NATIONAL ACADEMY OF SCIENCES OF THE REPUBLIC OF ARMENIA

INSTITUTE OF GEOLOGICAL SCIENCES

42nd INTERNATIONAL COMMISSION ON THE HISTORY OF GEOLOGICAL SCIENCES (INHIGEO) SYMPOSIUM

YEREVAN, ARMENIA, 12-18 SEPTEMBER 2017

50th Anniversary of INHIGEO 1967-2017

Yerevan 2017

ՀԱՅԱՍՏԱՆԻ ՀԱՆՐԱՊԵՏՈՒԹՅԱՆ ԳԻՏՈՒԹՅՈՒՆՆԵՐԻ ԱԶԳԱՅԻՆ ԱԿԱԴԵՄԻԱ

ԵՐԿՐԱԲԱՆԱԿԱՆ ԳԻՏՈՒԹՅՈՒՆՆԵՐԻ ԻՆՍՏԻՏՈՒՏ

ԵՐԿՐԱԲԱՆԱԿԱՆ ԳԻՏՈՒԹՅՈՒՆՆԵՐԻ ՊԱՏՄՈՒԹՅԱՆ ՄԻՋԱԶԳԱՅԻՆ ՀԱՆՁՆԱԺՈՂՈՎԻ (INHIGEO) 42-րդ ԳԻՏԱԺՈՂՈՎ
ԵՐԵՎԱՆ, ՀԱՅԱՍՏԱՆ, 12-18 ՍԵՊՏԵՄԲԵՐ 2017

INHIGEO-**Ի** 50-**ԱՄՅԱ ՏԱՐԵԼԻՑԸ**, 1967-2017

Երկրաբանական գիտությունների պատմության միջազգային հանձնաժողովի (INHIGEO) հիմնադրման մասին որոշումը կայացվել է 1967թ.-ին ՀԽՍՀ ԳԱ-ում տեղի ունեցած երկրաբանության պատմության միջազգային գիտաժողովում:

ԳԻՏԱԺՈՂՈՎԻ ԾՐԱԳԻՐ
ԷՔՍԿՈՒՐՍԻԱՆԵՐԻ ՈՒՂԵՑՈՒՅՑ
ՍԵՂՄԱԳՐԵՐԻ ԺՈՂՈՎԱԾՈՒ

Հեղինակներ և խմբագիրներ: Խ. Մելիքսեթյան, Ա. Փիլիպոսյան, Ռ. Ջրբաշյան, Ա. Կարախանյան, Ա. Ավագյան, Ռ. Բաղալյան, Բ. Գասպարյան, Դ. Մանուչարյան, Մ. Միսակյան

ԵՐԵՎԱՆ-2017

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INHIGEO was established during the International Symposium on the History of Geology held in the Armenian National Academy of Sciences in Yerevan, Armenia in 1967

CONFERENCE PROGRAM
EXCURSIONS GUIDEBOOK
ABSTRACTS VOLUME

Contributors and Editors: Kh. Meliksetian, A.Piliposyan, R.Jrbashyan, A. Karakhanyan, A. Avagyan. R. Badalayan, B. Gasparyan, D. Manucharyan, M.Misakyan

YEREVAN – 2017

INHIGEO-2017 HOST:

INSTITUTE OF GEOLOGICAL SCIENCES

OF THE NATIONAL ACADEMY OF SCIENCES OF ARMENIA

Institute was founded in 1935
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Geological research and education – (Master's and PhD)

Main Scientific Directions of the Institute of Geological Sciences (IGS):

- General and Regional Geology
- Geodynamics
- Seismotectonics
- Volcanology
- Assessment of Seismic, Volcanic and Other Geological Hazards
- Active Tectonics
- Hydro-geochemistry
- Phanerozoic Bio-chronological Stratigraphy and Paleontology
- Lithogenesis of Sedimentary and Volcano-sedimentary Formations
- Petrology and geochemistry of Magmatic and Metamorphic Formations
- Geology of Metallic and non-metallic Minerals, Metallogeny
- Geochemical Methods of Mineral Exploration
- Engineering Geology and Hydro-geology
- Geoinformatics and GIS
- Paleoenvironment
- Geoecology

Currently, the IGS employs over 160 people; more than 70 of them are members of the scientific staff of the following structural units: Geo-hazards and Geodynamics, Geomonitoring and Geoarchaeology, Minerals and Economic geology, Petrology and Isotope geochemistry, Lithology and Regional geology, Analytical chemistry, Geological informatics, Volcanology and Geological Museum.

The Institute cooperates with many research institutes from all over the world, namely, with Montpellier-II and Sophia-Antipolis of Nice Universities, France; University of South Florida, USA; Athens University of Greece; Russian Academy of Sciences; Geological Survey of Italy; Geological Survey of Iran; Academy of Sciences of Georgia; Karlsruhe Institute of Technology, Technical Universities of Dresden and Freiberg, University of Heidelberg, Germany; Universities of Vienna and Graz, Austria; Universities of Durham, Glasgow and Leeds, UK and many other leading research centers. Apart from its basic projects, funded by the Government of Armenia, the IGS has accomplished many assignments awarded in international tenders announced by different national and international organizations.

INHIGEO-2017 CONFERENCE THEMES

1. 50 years of INHIGEO
2. Development of geological ideas and concepts
3. History of geology in Armenia
4. Ancient knowledge of stone and metals
5. Studies of historic and prehistoric evidences of seismic and volcanic activity
6. General contributions and biographies of famous geologists

INHIGEO-2017 LOCAL ORGANIZING COMMITTEE

Academician Ruben Jrbashyan, Chairmen (Institute of Geological Sciences)

Dr.Sci. Arkady Karakhanyan (Institute of Geological Sciences)

Dr. Sci. Ashot Pilipossyan (Ministry Of Culture of The Republic Of Armenia)

Mr. Karapet Vardanyan (Adviser to Prime Minister of Armenia)

Dr. Khachatur Meliksetian (Institute of Geological Sciences)

Dr.Sci. Georgi Khomezuri (Institute of Geological Sciences)

Mr. Gourgen Malkhasyan (Vallex CJSCo)

INHIGEO-2017 CONFERENCE VENUE

The INHIGEO 2017 conference will be held at Round Hall of Presidium of the Armenian National Academy of Sciences- Armenian National Academy of Sciences in Yerevan, the same venue as International Symposium on the History of Geology in 1967.

ԳԻՏԱԺՈՂՈՎԻ ԾՐԱԳԻՐ

13-15 **Սեպտեմբեր**, *ՀՀ ԳԱԱ նախագահության* նիստերի *կլոր դահլիճ*

*13 **սեպտեմբեր***

08:00-09:00 **ԳՐԱՆՑՈՒՄ**

09:00-10:30 **Բացման խոսք**

ՀՀ վարչապետ պրն. Կարեն Կարապետյան

ՀՀ ԳԱԱ նախագահ ակադեմիկոս Ռադիկ Մարտիրոսյան

ՀՀ ԳԱԱ ակադեմիկոս, INHIGEO-2017 գիտաժողովի կազմկոմիտեի նախագահ ակադեմիկոս Ռուբեն Ջրբաշյան

INHIGEO-ի նախագահ պրոֆ. Բերի Քուփեր (զեկույց՝ INHIGEO-ի ստեղծման պատմությունը)

ՌԴ ԳԱ Երկրաբանական ինստիտուտի երկրաբանության պատմության բաժնի ղեկավար դոկտոր Իրինա Մալախովա

10:30 -11:00 ***Հոբելյանական գրքի շնորհանդես*. «Երկրագիտության պատմությունը. Նվիրված INHIGEO-ի 50-ամյա տարելիցին**: *Խմբագիրներ՝ Վ. Մեյեր, Ռ. Մ. Քլերի, Լ. Ֆ. Ազուելա, Թ. Ս. Մոտա և Ս. Վոլկովիչ (Լոնդոնի երկրաբանական հասարակության հատուկ հրատարակություններ, Լոնդոն-2017)»*

Արարողության ղեկավար՝ Բերի Քուփեր (INHIGEO-ի նախագահ), Մարիանե Քլեմուն (INHIGEO-ի գլխավոր քարտուղար). Երկրաբանության և գիտության պատմությունը գլոբալ շրջանակներում

Ներկայացնող՝ Թերեզա Սալոմե Մոտա. INHIGEO-ի 50-ամյա տարելիցին նվիրված հատորը. հետգրություն

11:00-11:30 **Սուրճի ընդմիջում**

I Նիստ, Նախագահ՝ պրոֆեսոր Ֆիլիպե Տաքեթ

11:30-11:50 **Մ. Սոսոն**. *Ա. Կարախանյան, Տ. Քանգարլի, Շ. Աղամիա, Վ. Սթարոսթենքո, Տ. Դանիելյան, Հ. Ֆիլիպ, Ջ. Ֆ. Ռիթց, Յ. Ռոլանդ, Մ. Հեսիշ, Դ. Բոշ, Բ. Սմիթ, Մ. Մեյջերս, Ա. Ավագյան, Լ. Սահակյան, Ղ. Գալոյան, Ռ. Մելքոնյան, Ն. Սադրաձե, Վ. Ալանիա, Օ. Ենուկիձե, Տ. Եգորովա, Օ. Գինտով, Ա. Մուրովսկայա, Յ. Շերեմետ.* «Հարավային Կովկասի երկրագիտություն» միջազգային գիտահետազոտական խմբի (IRG) գործունեության առանցքային դրույթները և ավանդը», Ֆրանսիա, Հայաստան, Ադրբեջան, Վրաստան և Ուկրաինա

11:50-12:10 **Գ. Մալխասյան**. Էդուարդ Մալխասյան՝ INHIGEO-ի առաջին անդամը Հայաստանում

12:10-12:30 **Խ. Մելիքսեթյան**. Հանքաքարերի և օբսիդիանի կիրառումը Հարավային Կովկասում, նախապատմական ժամանակաշրջանում

12:30-12:50 **Ա. Փիլիպոսյան**, *Խ. Մելիքսեթյան.* Անագի տարանցիկ առևտուրը հնագույն Մերձավոր Արևելքում եվ Հայկական լեռնաշխարհում, բրոնզե դարում

12:50-13:50 **Լանչի ընդմիջում**

II Նիստ. Նախագահ՝ դոկտոր Խաչատուր Մելիքսեթյան

13:50-14:10 **Գ. Գաբրիելյանց**, *Վ. Պորոսկուն.* Նավթի որոնման գիտական հիմքերի պատմությունը (գաղափարների, տեսությունների և հասկացությունների պայքար)

14:10-14:30 **Ռ. Ջրբաշյան**. *Գ. Խոմիզուրի.* Միջնադարյան հայ հեղինակների աշխատություններում հիշատակված երկրաբանական գիտելիքների պատմությունը

14:30-14:50 **Ռ. Մելքոնյան**. ՀՀ ԳԱԱ Երկրաբանական գիտությունների ինստիտուտի դերը Հայաստանի երկրաբանության պատմության մեջ

14:50-15:10 **Հ. Մելիք-Ադամյան**. Հայազգի երկրաբան Ն. Ի. Քարաքաշի կատարած հետազոտությունները Ղրիմում, Կովկասում և Հայաստանում

15:10-15:30 **Գ. Գրիգորյան**, *Ս. Ավագյան.* ՀՀ ԳԱԱ ԵԳԻ Հ. Կարապետյանի անվան երկրաբանական թանգարանի դերը Հայաստանի երկրաբանության պատմության մեջ

15:30-15:50 **Ա. Գրիգորյան**, *Հ. Մելիք-Ադամյան*. Եվրոպացի պալեոնտոլոգների ավանդը Հայկական լեռնաշխարհի պալեոզոյան հանքավայրերի ուսումնասիրության գործում (19-րդ դար)

15:50-16:10 **Կ. Վարդանյան**, *Գ. Հովսեփյան*. Հայաստանի Հանրապետության երկրաբանական հետախուզման պատմություն

16:10-16:30 **Ա. Ավանեսյան**. Հայաստանում երկրաբանական քարտեզագրման պատմության համառոտ ակնարկը

16:30-17:00 **Սուրճի ընդմիջում**

III Նիստ, Նախագահ՝ դոկտոր Ջոհաննես Մատես

17:00-17:20 **Է. Վաքարի**. Ներքնանձերի և կողմնակի անձանց միջև. INHIGEO-ն և երկրաբանության պատմությունը Հայաստանում

17:20-17:40 **Մ. Յաջիմա**. Թեիթի Կոբայասիի կատարած երկրաբանական և հնէաբանական ուսումնասիրությունները (1901-1997)

17:40-18:00 **Է. Հեմ**. Լեռներ, ռոմանտիկա, երկրաբանություն

Հայտարարություն Երկրաբանական գիտությունների պատմության միջազգային հանձնաժողովի (INHIGEO) 43-րդ գիտաժողովի վերաբերյալ

14 Սեպտեմբեր

IV Նիստ, Նախագահ՝ պրոֆեսոր Էռնստ Հեմ

09:00-09:20 **Ղ. Գալոյան**. Փոքր Կովկասի մեզոզոյան օֆիոլիթների երկրաբանական ուսումնասիրությունների պատմությունը (Հայաստան, Ղարաբաղ)

09:20-09:40 **Կ. Կոհեն**. Ջրհեղեղը, դելյուվիալիստները և դելյուվին վաղ երկրաբանության մեջ. Լայբնից մինչև Կյուվիե և այլք

09:40-10:00 **Գ. Գողարդ**. Դեյ Լինչեի ակադեմիան և վաղ երկրաբանությունը 1630-ական թթ.-ին

10:00-10:20 **Ի. Մալախովա**. Ռուսաստանի երկրաբանության պատմության որոշ առանձնահատկությունները

10:20-10:40 **Ջ. Մատեւ**. Օրգանականի և անօրգանականի միջև. անիմացիոն Երկրի հայեցակարգերը քարանձավային միներալների շուրջ բանավեճերում, վաղ ժամանակակից Եվրոպայում

10:40-11:00 **Մ. Քլեմուն.** Ինչպե՞ս Կովկասը դարձավ «մեր» Կովկասը. երկրաբանությունից մինչև լեռնագնացություն

11:00-11:30 **Սուրճի ընդմիջում**

V Նիստ, Նախագահ՝ պրոֆեսոր Ջոն Դիմեր

11:30-11:50 **Լ. Ֆ. Ազուելա**, *Ռ. Ա. Վեգա*. Երկրաբանությունը հանրային ոլորտում, Մեքսիկայում (1840-1876)

11:50-12:10 **Մ. Պովարյոնիխ**. Միներալոգիական հարացույցների փոփոխությունը միներալոգիայի՝ որպես գիտություն, 350-ամյա գոյության ընթացքում

12:10-12:30 **Պ. Ռիչեթ**. 1751-1798. Հրաբխագիտության անսպասելի մեկնարկը

12:30-12:50 **Պ. Կոնեցնի**. Կամերիալիզմի և բնական գիտության միջև. վեռներյան գեոգնոզիան և հանքային ռեսուրսների ուսումնասիրությունը Հունգարական հանքարդյունաբերության վարչությունում, 19-րդ դարի առաջին կեսին

12:50-13:50 **Լանչի ընդմիջում**

VI Նիստ, Նախագահ՝ դոկտոր Իրինա Մալախովա

13:50-14:10 **Ռ. Մ. Քլերի, Թ. Շարփ**. Երկրի ամենահեռավոր ավարտը. Երկրաբանական հետախուզության դերը Անտարկտիկայի հետախուզման գործում, 1895-1922թթ.

14:10-14:30 **Մ. Վոլկովիչ**, *Ք. Վոլկովիչ, Մ. Գրանիչնի, Հ. Ուրբան*. Լեհաստանի երկրաբանական քարտեզի էվոլուցիան 19-րդ դարում

14:30-14:50 **Մ. Ռոուլենդ**. Միխայիլ Լոմոնոսովի անսովոր տեսակետը մարդկային քաղաքակրթության վրա երկրաշարժերի ունեցած բարենպաստ ազդեցության վերաբերյալ (18-րդ դարի կեսեր)

14:50-15:10 **Ա. Կազարյան**. Երկրաշարժերի երկրաքիմիական կանխատեսման մարտահրավերը. խնդրի պատմությունը

15:10-15:30 **Ռ. Շվաբ**. *Խ. Մելիքսեթյան, Ս. Քրաուս, Է. Պերնիցկա*. Արսենով հարուստ բացառիկ համաձուլվածքների կիրառումը ոսկերչության մեջ Հայաստանում, բրոնզե դարաշրջանում

15:30-15:50 **Ա. Ռիդռուդ**, *Բ. Հելի*. Հին կառույցներ և սեյսմիկ մշակույթներ Հայաստանում

15:50-16:10 **Ա. Ավագյան**, *Լ. Սահակյան. Մ. Մարտիրոսյան. Թ. Աթալյան, Ա. Հայրապետյան*. Ուժեղ երկրաշարժի կրկնության պալեոսեյսմաբանական վկայությունները Շիրակի ավազանում

16:10-16:40 **Սուրճի ընդմիջում**

VII Նիստ, Նախագահ՝ դոկտոր Մայքլ Ջոնսթոն

16:40-17:00 **Ք. Գուերա**. Դոգս այրը (The Dog's Grotto). Առեղծվածային գազի վերաբերյալ երկրաբանական հարցումներ (18-19-րդ դարեր)

17:00-17:20 **Ա. Կարնեիրո**. *Պ. Ուրգե*. Ների Դելգադո (1835-1908). Երկրաբանի կարիերան դիվանագիտական հարթության վրա

17:20-17:40 **Բ. Քուփեր**. *Ջ. Ջագո*. Ռոբերտ Բեդֆորդ (1874-1951). Ծագումով ավստրալիացի երկրաբանի առանձնահատուկ ավանդը երկրաբանության մեջ

17:40-18:00 **Դ. Ջաք**. *Ք. Է. Մ. Քինգ*, առաջին կին գեոմորֆոլոգը

ՀՀ կառավարության ելույթ. Հայաստանի կողմից «Հանքարդյունաբերության ոլորտի թափանցիկության բարելավում (EITI)» , Թվային երկրաբանական ֆոնդի ներկայացում. www.geo-fund.am

15 Սեպտեմբեր

VIII Նիստ, Նախագահ՝ դոկտոր Շարադ Մասթեր

09:00-09:20 **Հ. Ուրբան**, *Մ. Գրանիչնի, Ք. Վոլկովիչ, Ս. Վոլկովիչ*. Պրոֆ. Էդվարդ Ռյուլե (1905 – 1988), լեհական ժամանակակից երկրաբանական քարտեզագրության հիմնադիրը

09:20-09:40 **Ջ. Դիմեր**. Բրածոներ, քարտեզներ, թանգարաններ և համագործակցություն. Շվեդիայում Մուրչիսոնի 1845թ.-ի դաշտային արշավի հաջողության բանալիները

09:40-10:00 **Կ. Վոլկովիչ**, *Մ. Գրանիչնի, Ս. Վոլկովիչ, Հ. Ուրբան*. Շքեղություն և ստվերներ, որոնք պատմում են Յան Վայզիկովսկու (1917 – 1976) կյանքի և Լեհաստանում «մեծ պղնձի» հայտնաբերման մասին

10:00-10:20 **Լ. Կոլբանցև**. Վլադիմիր Լոդոչնիկովը և ռուսական պետրոգրաֆիական դպրոցները

10:20-10:40 **Մ. Նապոլիտանի**. Երկրի մասին գիտությունների ձևավորումը միներալային հավաքածուների միջոցով. *Էքոլ Փարիզ Թեք-ի միներալոգիայի թանգարանը, կունստկամերայից մինչև Գիտության թանգարան* (1783-1803)

10:40-11:00 **Մ. Պանտալոնի**, *Ֆ. Կոնզոլե, Ֆ. Մ. Պետի*. Հերման Աբիխի հետքերով Իտալիայում. ճանապարհորդություն դեպի Իտալիայի հրաբուխները

11:00-11:30 Սուրճի ընդմիջում

IX Նիստ, Նախագահ՝ պրոֆեսոր Էցիո Վաքարի

11:30-11:50 **Մ. Քյոլբ-Էբերթ**. Փակելով երկաթե վարագույրը. Ինչպե՞ս երկրաբանները Գերմանիայում վերապրեցին Սառը պատերազմի սկիզբը

11:50-12:10 **Ն. Բրյանչանինովա**, *Ի Վտորով, Ա. Մակին*. Ֆ. Լևինսոն Լեսինգի ղեկավարած անդրկովկասյան ակադեմիական արշավախումբը (1927-1930)

12:10-12:30 **Ֆ. Տաքեթ**. Ջոզեֆ Փենթլենդ և Ժորժ Կյուվիե. Անգլո-ֆրանսիական համաձայնագիր

12:30-12:50 **Շ. Մասթեր**. Հարավաֆրիկացի երկրաբան Ալեքս Լ. Դու Թոյթը, մայրցամաքային դրեյֆի ռահվիրան Կովկասում (17-րդ Միջազգային երկրաբանական կոնգրես, հուլիս, 1937). էքսկուրսիայի օրագրերը և նկարները

12:50-13:50 **Լանչի ընդմիջում**

X Նիստ, Նախագահ՝ Պրոֆեսոր Սթեֆեն Ռոուլենդ

13:50-14:10 **Ս. Ֆիգերոա**. «Թաքնված գործիչ». Օսկար Ներվալ Դե Գուվեա (1856-1915). Միներալոգիան և բժշկությունը Բրազիլիայում

14:10-14:30 **Ս. Նաթան**. Ջեյմս Հեկտորը (1834-1907) և Նոր Զելանդիայի երկրաբանական հետախուզության ծնունդը

14:30-14:50 **Թ. Ս. Մոտա**. Ֆրանցիսկո Լուիս Պերեիրա դե Սոուսա (1870—1931). «գիտությանը նվիրված անձնավորության» գիտական կյանքը Պորտուգալիայում, 20-րդ դարի սկզբին

14:50-15:20 **Սուրճի ընդմիջում**

XI Նիստ, Նախագահ՝ պրոֆեսոր Գասթոն Գոդարդ

15:20-15:40 **Տ. Յամադա**. Թանգարանների նշանակությունը. «Երկրագիտության» հայեցակարգի ընկալման հիմքերը Թեիթի Կոբայասիի կողմից, 1940-ական թթ.-ին

15:40-16:00 **Զ. Բեսուդնովա**. Երկրաբանության պատմության մասին առաջին մենագրության հեղինակ Գրիգորի Ե. Շչուրովսկու ժառանգությունը Վերնադսկու պետական երկրաբանական թանգարանի հավաքածուներում

16:00-16:20 **Մ. Աղիուկու-Բրաուն**, *Օ. Աղիուկու Բրաուն*. Քարերի և մետաղների մասին հնագույն գիտելիքների ազդեցությունն Աֆրիկայի վրա

16:20-18:00 **Պաստառների նիստ, Նախագահ՝ պրոֆեսոր Դորոթի Զաք**

Գ. Գրիգորյան, Գ. *Խոմիզուրի, Մ. Միսակյան*. Լ. Ա. Սպենդիարովի անվան մրցանակ

Հ. Հովակիմյան. Սիսիանի պալեոլճի դիատոմային ջրիմուռների արձանագրությունների պատմական ակնարկը (Հայաստան)

Հ. Մելիք-Ադամյան. *Խ. Խաչանով*. Հանքարդյունաբերության և երկրաբանական ուսումնասիրությունների սկզբնական փուլերը Արցախի հնագույն հայկական տարածաշրջանում

Ի. Մալախովա. *Ի Վտորով*. INHIGEO-ի մեկնարկը Հայաստանում

Լ. Կոլբանցև. *Զ. Բեսուդնովա*. INHIGEO-ի անհատները. Մադրիդից (2010) մինչև Քեյփ Թաուն (2016)

Մ. Մարտիրոսյան, *Ա. Ավագյան, Ս. Վարդանյան, Տ. Գրիգորյան*. Պալեոսեյսմաբանական ուսումնասիրություններ Փամբակ-Սևան-Սյունիք ակտիվ խզվածքի Քարքար-Ծղուկ փուլլ-ափարթի արևելյան ճյուղի վրա:

Ռ. Մելքոնյան. *Լ. Աթայան*. Հեղինակավոր միներոլոգ և պետրոլոգ Վլադիմիր Նիկիտա Լոդոչնիկովը (Վարդան Մկրտիչ Գայակչյան)

Ս. Վարդանյան, *Ռ. Միրիջանյան, Հ. Հովակիմյան*. Վեդի-Եղեգնաձոր շրջանի երկրաբանական կառույցների մեկնաբանությունները անցյալ դարաշրջանում

Շ. Մաաթեր. Գեոմորֆոլոգիական տեսությունը 10-րդ դարում Բասրայում (Իրաք). Ազնվության եղբայրների (The Brethren of Purity- Ikhwan Al-Safa) ուղերձները աշխարհագրական համատեքստում

Ս. Վոլկովիչ. *Ք.* Վոլկովիչ. Կերչ և Թաման թերակղզիների երկրաբանական քարտեզը

Մ. Գրանիչնի, *Ս. Վոլկովիչ, Հ. Ուրբան, Ք. Վոլկովիչ*. Յան Սամսոնովիչ (1888 – 1959).լեհ հեղինակավոր հետազոտող և երկրաբանների մի քանի սերունդների ուսուցիչ

Թ. Աթայյան, *Ա. Ավագյան, Դ. Առաքելյան, Մ. Մարտիրոսյան*. Երկրաբանական ազդեցությունը Սբ. Հովհաննես Կարապետ վանքի վրա

18:00 **INHIGEO-ի բիզնես հանդիպում**

INHIGEO-ի Ռուսական խմբի բիզնես հանդիպում

20:00 **Գիտաժողովի բանկետ Պանդոկ Երևան ռեստորանում**

CONFERENCE PROGRAM

13-15 September, ROUND HALL OF PRESIDIUM OF THE NATIONAL ACADEMY OF SCIENCES OF THE REPUBLIC OF ARMENIA

13 SEPTEMBER

08:00-09:00 REGISTRATION

09:00-10:30 Introduction and Welcome address by

Prime Minister of Armenia, Mr. Karen Karapetyan

President of the National Academy of Sciences of Armenia, Academician Radik Martirosyan

Academician of the National Academy of Sciences of Armenia, head of INHIGEO-2017 Organizing Committee, Academician Ruben Jrbashyan

President of INHIGEO, Prof. Barry Cooper (Presentation: The beginnings of INHIGEO)

Head of Department for the History of Geology of Geological Institute of the Russian Academy of Sciences, Dr. Irena Malakhova

10.30 -11.00 ***Anniversary book launch***- History of Geoscience: Celebrating 50 Years of INHIGEO; *Edited by W. Mayer, R.M. Clary, L.F. Azuela, T.S. Mota and S. Wolkowicz (Geological Society London Special Publications, Series*, London, 2017)

Master of Ceremonies: Barry Cooper (President of INHIGEO); Marianne Klemun (Secretary General of INHIGEO) - History of Geology and History of Science in a global frame

Presenter of the book: Teresa Salome Mota-The INHIGEO 50th Anniversary Volume: a Post-Scriptum

11:00-11:30 Coffee break

Session I, Chairperson: Prof. Phillipe Taquet

11:30-11:50 M. Sosson. *A. Karakhanyan, T. Kangarli, Sh. Adamia, V. Starostenko, T. Danelian, H. Phillip, J. F. Ritz, Y. Rolland, M. Hässig, D. Bosch, B. Smith, M. Meijers, A. Avagyan, L. Sahakyan, Gh. Galoyan, R. Melkonian, N. Sadradze, V. Alania, O. Enukidze, T. Yegorova, O. Gintov, A. Murovskaya, Y. Sheremet.* The highlights and the contribution of International Research Group (IRG) “South Caucasus Geosciences”: France, Armenia, Azerbaijan, Georgia and Ukraine

11:50-12:10 G. Malkhasyan. Edward Malkhasyan - the first INHIGEO member in Armenia

12:10-12:30 Kh. Meliksetian. Prehistoric use of ores and obsidian in the southern Caucasus

12:30-12:50 A. Piliposyan, *Kh. Meliksetian*. Tranzit trade of tin in ancient Near East in Bronze Age and Armenian Highland

12:50-13:50 Lunch break

Session II, Chairperson: Dr. Khachatur Meliksetian

13:50-14:10 G. Gabrielyants, *V.Poroskun*. The history of scientific foundations of oil exploration (battle of ideas, theories and concepts)

14:10-14:30 R. Jrbashyan, *G. Khomizuri*. History of geological knowledge in the works of medieval Armenian authors

14:30-14:50 R. Melkonyan. The role of Institute of Geological Sciences of NAS RA in the history of geology in Armenia

14:50-15:10 H. Melik-Adamyan. Research in the Crimea, the Caucasus and Armenia by Armenian geologist N.I.Karakash

15:10-15:30 G. Grigoryan, *S. Avagyan.* The role of Geological Museum after Hovhannes Karapetyan of IGS NAS RA in the history of geology in Armenia

15:30-15:50 A. Grigoryan, *H. Melik-Adamyan.* Contribution of European paleontologists to the study of Paleozoic deposits of the Armenian Highlands (XIXc)

15:50-16:10 K. Vardanyan, *G. Hovsepyan*. The history of Geological Survey of the Republic of Armenia

16:10-16:30 A. Avanesyan. An overview of the history of geological mapping in Armenia

16:30-17:00 Coffee break

Session III, Chairperson: Dr. Johannes Mattes

17:00-17:20 E. Vaccari. Between insiders and outsiders: INHIGEO and the history of geology in Italy

17:20-17:40 M. Yajima. Geological and Palaeontological Studies by Teiichi Kobayashi (1901-1997)

17:40-18:00 E. Hamm. Mountains, Romantics, Geology

Announcement about the 43rd International Commission on the History of Geological Sciences

14 SEPTEMBER

Session IV, Chairperson: Prof. Ernst Hamm

09:00-09:20 Gh. Galoyan. History of geological studies of Mesozoic ophiolites of the Lesser Caucasus (Armenia, Karabakh)

09:20-09:40 C. Cohen. Deluge, Diluvialists and Diluvium in early Geology, From Leibniz to Cuvier and beyond

09:40-10:00 G. Godard.The Accademia dei Lincei and the early geology around the year 1630

10:00-10:20 I. Malakhova. Some features of the history of geology in Russia

10:20-10:40 J. Mattes. Between the Organic and Inorganic: Concepts of an Animated Earth in the Debates on Cave Minerals in Early Modern Europe

10:40-11:00 M. Klemun. How the Caucasus became ‘our’ Caucasus: from geology to alpinism

11:00-11:30 Coffee break

Session V, Chairperson: Prof. John Diemer

11:30-11:50 L. F. Azuela, *R. A.Vega.* Geology in the public sphere in Mexico (1840-1876)

11:50-12:10 M. Povarennykh.Changeover of mineralogical paradigms during the 350-year period of the existence of mineralogy as a science

12:10-12:30 P. Richet.1751-1798: The sudden beginnings of volcanology

12:30-12:50 P. Konečný. Between Cameralism and Natural Science: Wernerian Geognosy and Exploration of Mineral Resources in Hungarian Mining Administration during the first half of the 19th Century

12:50-13:50 Lunch break

Session VI, Chairperson: Dr. Irena Malakhova

13:50-14:10 R. M. Clary, *T. Sharpe.* The furthest end of the earth: The role of geological research in Antarctic exploration, 1895-1922

14:10-14:30 S. Wołkowicz, *K. Wołkowicz, M. Graniczny, H. Urban*. Evolution of geological map of Poland in the 19th century

14:30-14:50 S. Rowland. Mikhail Lomonosov's unusual mid-eighteenth-century view on the beneficent effect of earthquakes on human civilization

14:50-15:10 A. Kazarian. The challenge of geochemical earthquake prediction-History of the problem

15:10-15:30 R. Schwab, *Kh. Meliksetian, S. Kraus, E. Pernicka*. Extraordinary arsenic-rich alloys used for jewellery in Bronze Age Armenia

15:30-15:50 A. Rideaud, *B. Helly*. Ancient Buildings and Seismic Cultures: The cases in Armenia

15:50-16:10 A. Avagyan, *L. Sahakyan, M. Martirosyan, T.Atalyan, A. Hayrapetyan.* Palaeoseismological evidences of strong earthquake repetition in Shirak basin

16:10-16:40 Coffee break

Session VII, Chairperson: Dr. Michael Johnston

16:40-17:00 C. Guerra. The Dog's Grotto: Geological inquiries for a mysterious gas (18th-19th centuries)

17:00-17:20 A. Carneiro, *P. Urze*. Nery Delgado (1835-1908): The diplomatic dimension of a geologist's career

17:20-17:40 B. Cooper, *J. Jago.* Robert Bedford (1874-1951): A unique contributor to international geology from the Australian outback

17:40-18:00 D. Sack. C.A.M. king, pioneering (woman) geomorphologist

Presentation by the Government of the Republic of Armenia"- Implementation process of Armenia to the International Extractive Industries Transparency Initiative (EITI)"; Presentation of Digital geological fund: www.geo-fund.am

15 SEPTEMBER

Session VIII, Chairperson: Dr. Sharad Master

09:00-09:20 H. Urban, *M. Graniczny, K. Wołkowicz, S. Wołkowicz*. Professor Edward Rühle (1905 – 1988), creator of the Polish modern geological cartography

09:20-09:40 J. Diemer. Fossils, maps, museums and collaboration: keys to success in Murchison's 1845 field campaign in Sweden.

09:40-10:00 K. Wołkowicz, *M. Graniczny, S. Wołkowicz, H. Urban*.Splendors and shadows which is about the life of Jan Wyżykowski (1917 – 1976) and the discovery of the "great copper" in Poland

10:00-10:20 L. Kolbantsev. Vladimir Lodochnikov and Russian Petrographic Schools

10:20-10:40 M. Napolitani. Building Earth Sciences through Mineral Collections. The Mineralogy Museum of the Parisian École des Mines, from the Curiosity Cabinet to the Science Museum (1783-1803)

10:40- 11:00 M. Pantaloni, *F. Console, F. M. Petti*. On the trail of Hermann Abich in Italy: a journey through the Italian volcanoes

11:00-11:30 Coffee break

Session IX, Chairperson: Prof. Ezio Vaccari

11:30-11:50 M. Kölbl-Ebert. Closing the iron curtain: How geologists in Germany experienced the beginnings of the Cold War era

11:50-12:10 N. Bryanchaninova, *I. Vtorov, A. Makeyev.* Transcaucasian academic expedition (1927-1930) led by F. Loewinson-Lessing

12:10-12:30 Ph. Taquet. Joseph Pentland and Georges Cuvier: A French - British Entente cordiale

12:30-12:50 Sh. Master. South African geologist Alex L. Du Toit, pioneer of continental drift, in the Caucasus (17th IGC, July, 1937) - diaries and photographs of an excursion

12:50-13:50 Lunch break

Session X, Chairperson: Prof. Stephen Rowland

13:50-14:10 S. Figueirôa. A ‘Hidden figure’: Oscar Nerval De Gouvêa (1856-1915), Mineralogy & Medicine in Brazil

14:10-14:30 S. Nathan. James Hector (1834-1907) and the birth of the New Zealand geological survey

14:30-14:50 T. S. Mota. Francisco Luís Pereira de Sousa (1870—1931): the scientific life of a ‘everyday man of science’ in Portugal in the beginning of the 20th century

14:50-15:20 Coffee break

Session XI, Chairperson: Prof. Gaston Godard

15:20-15:40 T. Yamada. The meaning of museums: The background of the geologist Teiichi Kobayashi’s ‘geoscience’ conception in the 1940s

15:40-16:00 Z. Bessudnova. The heritage of the author of the first Russian monograph on the history of geology Grigory E. Shchurovsky in the collections of Vernadsky State Geological Museum

16:00-16:20 M. Adiuku-Brown,*O. Adiuku-Brown.*The impact of ancient knowledge of stones and metals on Africa

16:20-18:00 POSTER SESSION, Chairperson: Prof. Dorothy Sack

G. Grigoryan, *G. Khomizuri, M. Misakyan.* L. A. Spendiarov Prize

H. Hovakimyan. Historical overview of diatom records from Sisian palaeolake (Armenia)

H. Melik-Adamyan., *Kh. Khachanov*. Initial stages of mining and geological studies of the ancient Armenian region of Artsakh

I. Malakhova., *I. Vtorov*. It began with Yerevan

L. Kolbantsev, *Z. Bessudnova,* Personalities of INHIGEO: from Madrid (2010) to Cape Town (2016)

M. Martirosyan, *A. Avagyan, S. Vardanyan, T. Grigoryan.*
Paleoseismological studies of the eastern part of Karkar-Tsghuk pull-apart of Pambak-Sevan-Syunik active fault

R. Melkonyan, *L. Atayan.* The outstanding mineralogist and petrologist Vladimir Nikita Lodochnikov (Vardan Mkrtich Gayakchyan)

S. Vardanyan, *R. Mirijanyan, H. Hovakimyan.* Interpretations of geological structures of Vedi -Yeghegnadzor area over the past century

Sh. Master. Geomorphological theory in 10th century Basra (Iraq): The epistles of the brethren of purity (Ikhwan Al-Safa), in geographical context

S. Wołkowicz, *K. Wołkowicz.* Geological map of the Kerch and Taman Peninsulas (1851) – Interesting map developed by Hermann Abich (1806-1886)

M. Graniczny, S. Wolkowicz, H. Urban, K. Wołkowicz. Jan Samsonowicz (1888 – 1959) outstanding Polish explorer and educator of the several generations of geologists

T. Atalyan, *A.Avagyan, D. Arakelyan, M. Martirosyan*. Geological impact on St. Hovhannes Karapet Monastery

18:00 INHIGEO business meeting

Business meeting of the Russian Group of INHIGEO

20:00 Conference dinner at Pandok Yerevan Restaurant

INTRODUCTION

The Republic of Armenia is landlocked country, with a total area of 29,800.00 km^2, located in the southern part of Caucasus in the NE part of the Armenian Highland. Armenian Highland is an orogenic elevated plateau, intensely deformed central segment of the Alpine-Himalayan belt.

The relief of the country is diverse. It is made up of folded mountain ridges, volcanic uplands and plateaus, intermountain depressions. The highest point of the country is Mount Aragats volcano (4090 m). The scenic freshwater Lake Sevan with an area of 1,242 km^2 lies in the heart of Armenia; altitude of water surface is 1904 m. a.s.l.. Lake Sevan is one the largest among high mountain lakes of the world.

Yerevan is the capital and the largest city of Armenia as well as one of the world's oldest continuously inhabited cities. It will celebrate its 2800-year anniversary in 2018. The history of Yerevan dates back to the 8th century BC, with founding of the fortress of Erebuni in 782 BC by Urartian king Argishti I, son of Menua. Situated along the Hrazdan River, Yerevan is the administrative, cultural, and industrial center of the country. It has been the capital since 1918, and is the thirteenth in the history of Armenia.

Brief overview of regional geology

The Republic of Armenia and neighboring areas of Azerbaijan, Georgia, Eastern Turkey, and NW Iran are located in the central part of the Arabia-Eurasia collision zone (Figure 1). This region was formed as a result of the accretion of continental fragments to the southern Eurasian margin by the Late Cretaceous to the Early Tertiary (Sengör, 1990; Sosson et al., 2010, Rolland, 2017). Based on global positioning system (GPS) data, Arabia is moving northward relative to Eurasia at a rate of ~17 mm/yr (Reilinger et al., 2006; Vernant et al., 2004). Internal deformations of collisional plateau take place mostly along strike-slip fault systems such as PSSF and others, at rates around ≤2 mm/yr, (Karakhanian et al., 2013). Recent and active deformations are mainly characterized by strike-slip tectonics and associated pull-apart, horsetail splay structures (Karakhanyan et al, 2003).

Three main geologic units (terranes) and three overimposed magmatic belts related to changes in geodynamic settings are identified within Armenia and neighbouring areas of Lesser Caucasus. Three main geologic units are 1. South Armenian block, (SAB) a continental block of Gondwanaland origin with Proterozoic metamorphic basement, 2. Lesser Caucasus Mesozoic Island arc (LCMIA) or Somkheto-Karabakh Belt – according to Lordkipanidze, (1980), it is considered a fragment of regional Pontic-Lesser Caucasus – Alborz volcanic palaeo-island arc. 3. Amasia-Sevan-Akera ophiolite suture zone (ASASZ), part of regional ophiolite suture zone extended further west to Ankara-Erzincan ophiolite (Knipper&Khain, 1980, Galoyan et al., 2009). These main units also consist of smaller blocks and fragments. Since the SAB and LCMIA units were merged after Upper-Cretaceous – Palaeocene collision, marked by ASASZ, further magmatism (Eocene to Quaternary) is overimposed over the above mentioned units, namely: regional Palaeogene “andesitic” belt, Late Oligocene – Early Miocene magmatism and post-collisional, Late Miocene-Quaternary volcanic belt. Schematic geological map of Lesser Caucasus and adjacent areas of Turkey and Iran, are shown on Figure 2.

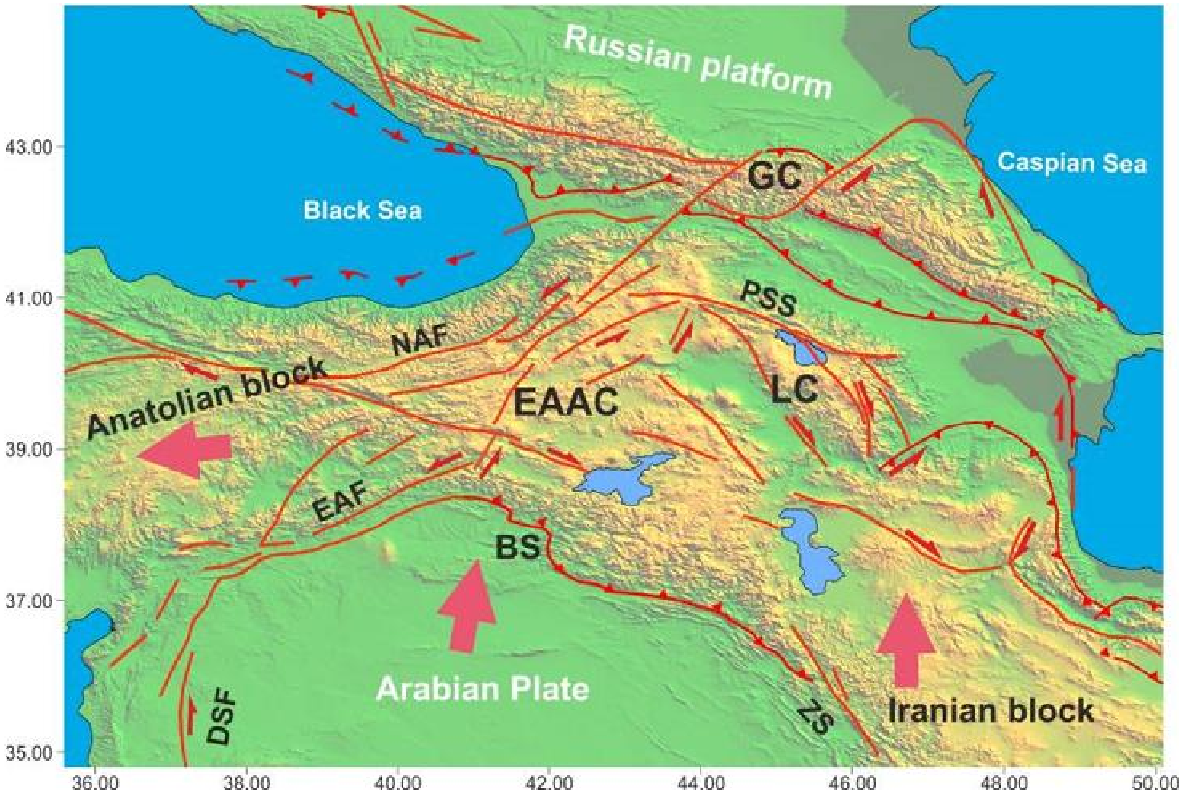

Figure 1. Simplified map showing tectonic units within and surrounding Armenia (Phillip et al., 1989; Karakhanian et al., 2003, 2013, Zor, 2008, Avagyan et al, 2010). Current complex geological structure of the studied region is formed mainly by convergence and collision of Arabian plate and the active margin of Eurasia, wedging-in of Arabian northern margin and resulting ejection to the sides of Anatolian and Iranian blocks with the Armenian Highland in the centre (Phillip, et al., 1989, Avagyan et al., 2010). Map key: North Anatolian fault (NAF), East Anatolian fault (EAF), Dead Sea fault (DSF), Bitlis suture (BS), Zagros suture (ZS), Pambak-Sevan-Syunik fault (PSS), Great Caucasus (GC), East Anatolian accretionary complex (EAAC), Lesser Caucasus (LC).

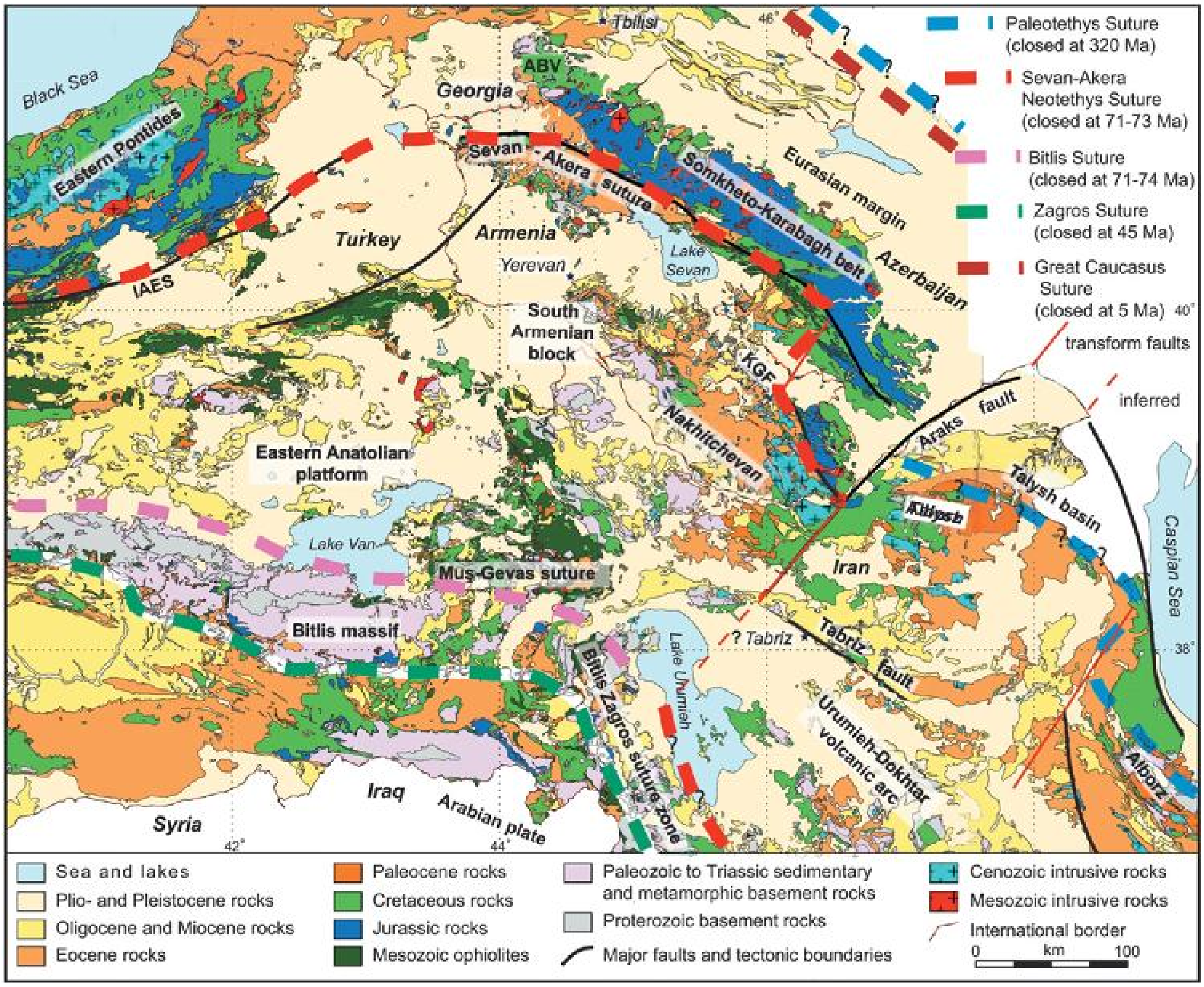

Figure 2. Sketch geological map of Armenia, Lesser Caucasus, Eastern Turkey, Georgia and NW Iran with major suture zones and faults (after Rolland, 2017).

Seismicity and active tectonics

The Lesser Caucasus experiences N-S shortening and E-W extension, accompanied by faulting and earthquakes (Dewey et al., 1986; Jackson, 1992; Avagyan et al., 2010). The faults in Armenia and surrounding areas are generally strike-slip faults with either reverse-slip or normal-slip components (Karakhanian et al., 2004). Active deformations are mainly characterized by strike-slip tectonics, associated locally with transpression or transtension and can be characterized by four major coeval fault patterns: NW-SE-trending right-lateral strike-slip; NE-SW-trending left-lateral strike-slip; E-W-trending reverse; and N-S-trending normal faults (Philip et al., 1989; Karakhanian et al., 2004; Avagyan et al., 2010; Ritz et al., 2015, Karakhanyan et al., 2016).

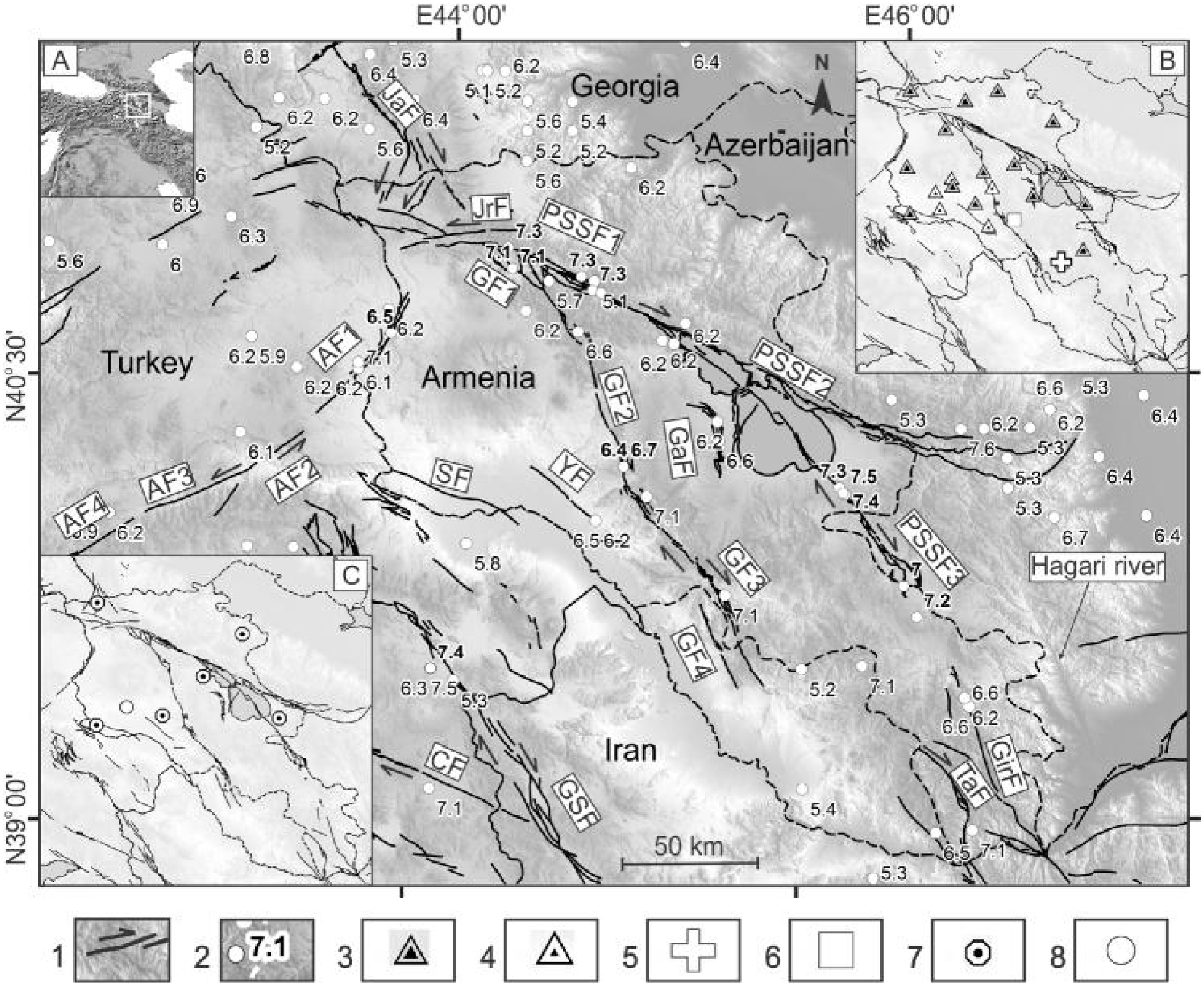

Figure 3. Map of active faults and strong earthquakes in Armenia and adjacent countries. 1—active faults; 2—epicenters of strong earthquakes with indication of event magnitude; 3—broadband seismic stations of the Institute of Geological Sciences of the National Academy of Sciences of Armenia; 4—broadband seismic stations of the Armenian Seismic Survey; 5—the seismic array system; 6—Incorporated Research Institutions for Seismology (IRIS) seismic station; 7— continuous global positioning system (GPS) stations of the Institute of Geological Sciences of the National Academy of Sciences of Armenia; 8—continuous GPS station of the Armenian Seismic Survey. PSSF1, PSSF2, and PSSF3— segments of the Pambak-Sevan-Syunik fault; GF1, GF2, GF3, and GF4—segments of the Garni fault; AF1, AF2, AF3, and AF4—segments of the Akhouryan fault; JaF—Javakhq fault; JrF—Jeltaya Rechka fault; GaF—Gavaraghet fault; YF—Yerevan fault; SF—Sardarapat fault; TaF—Tashtoun fault; GirF—Giratakh fault; GSF—Gailatu-Siah Cheshmeh fault; CF—Chaldiran fault. Insets: (A) location of Armenia; (B) modern seismic network of the Armenia; (C) network of continuous GPS stations in Armenia. (after Karakhanyan et al., 2016)

The most important active fault system in Armenia, the Pambak-Sevan-Syunik fault system (Figure 3), is a 400-km-long NW-SE right-lateral strike-slip fault. The present long-term horizontal slip rate along the fault varies between 0.5 and 3-4 mm/yr (Philip et al., 2001; Trifonov and Karakhanyan, 2008), which is consistent with the GPS-measured 0.3-3 mm/yr (Reilinger et al., 2006; Karakhanyan et al., 2013). The 200-km-long Garni fault is another large right-lateral strike-slip fault with alternating reverse and normal slip components (Fig. 3) and an estimated 3 mm/yr horizontal slip rate (Trifonov and Karakhanyan, 2008), which is consistent with 0.6 mm/yr GPS measurements (Karakhanian et al., 2013).

Paleoseismological and archaeoseismological studies of last decades showthat the Pambak-Sevan-Syunik fault system and the Garni fault generated earthquakes with magnitude up to M_w 7.5 (Philip et al., 2001; Karakhanian et al., 2004; Trifonov and Karakhanyan, 2008; Avagyan, 2009; Morino et al., 2012, 2013; Ritz et al., 2015, Karakhanyan et al., 2016).

Historical data proves that Armenia has been affected by many destructive earthquakes (Stepanian, 1964; Ambraseys and Melville, 1982; Berberian, 1994, 1997; Guidoboni and Traina, 1995; Karakhanyan and Abgaryan, 2004; Karakhanyan et al., 2011). Old cities and capitals of Armenia, such as Yerznka, Dvin, and Ani, were repeatedly ruined by strong earthquakes. Yerevan, the present capital city, was strongly damaged by the Garni earthquake of 1679. The largest historical earthquake is estimated to have had a magnitude of 7.5 for the event of 1139 CE on the Pambak-Sevan-Syunik fault system (Nikonov and Nikonova, 1986). Strong seismic activity and active tectonics in the region of Caucasus are also indicated by the record of instrumental seismicity with damaging earthquakes in Chaldiran (1976, M = 7.1), Norman (1983, M = 7.1), Spitak (1988, M = 6.9), Racha (1991, M = 7.1), and Van (2011, M = 7.2; Fig. 1).

Quaternary Volcanism

Collisional events result in formation and growth of the Anatolian-Armenian-Iranian elevated post-collisional orogenic plateau, where Neogene-Quaternary volcanism is widespread and considered a key feature of the entire region, see Figure 4. Volcanism produced huge volumes of lava flows and pyroclastic products, quite variable in compositions, eruption styles and explosivity (Pearce et al., 1990; Keskin et al., 1998; Yilmaz et al., 1998, Neill et al., 2013, Karapetyan et al., 2001, Meliksetian 2012, Meliksetian et al, 2014). In Armenia voluminous Pliocene-Quaternary volcanism covers about half of the territory of the country and is presented by lava flows, pyroclasts, ignimbrites, extrusives, ranging in compositions from basalts and basanites to rhyolites. Three distinct types of volcanism were identified for the Lesser Caucasus: fissure, areal and central-vent (Shirinyan 1970; Jrbashyan et al. 1996).

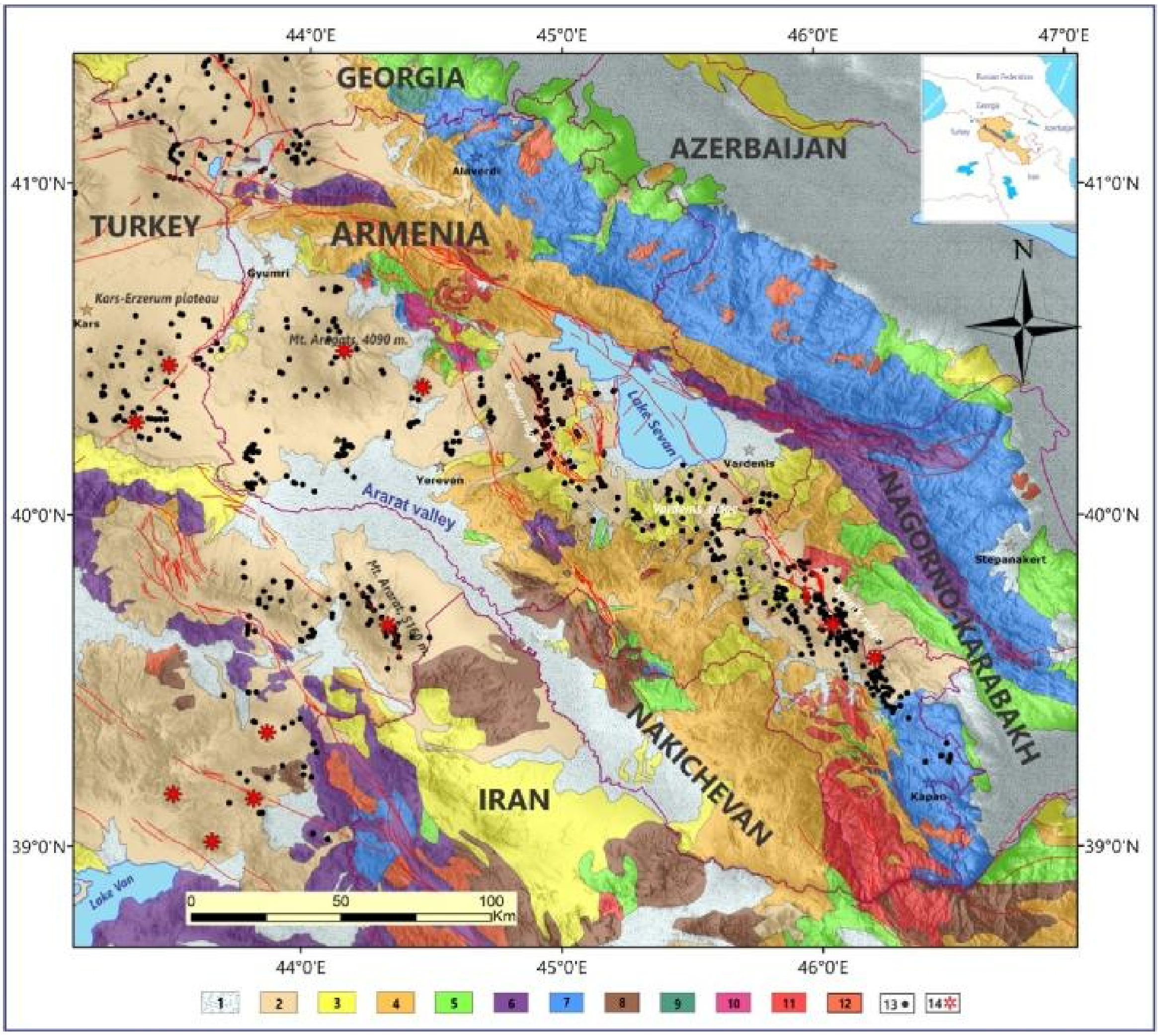

Figure 4. Simplified geological map of Armenia and adjacent areas. Legend: 1. Quaternary sediments; 2. Upper Pliocene-Quaternary volcanic units; 3. Neogene volcanic and sedimentary units; 4. Paleogene volcanic and sedimentary units; 5. Ophiolite complexes Amasia-Sevan-Akera suture zone (ASASZ); 6. Upper Cretaceous volcanic and sedimentary units Arc of Lesser Caucasus (ALS). 7. Jurassic-Lower Cretaceous island arc units of ALS; 8. Paleozoic - Triassic platform sedimentary cover of SAB; 9. Variscan (Paleozoic) metamorphic basement of Eurasian margin; 10 Proterozoic metamorphic basement of SAB; 11.Cenozoic intrusions; 12. Mesozoic intrusions. 13. Volcanoes. 14. Stratovolcanoes. Major faults after Karakhanyan et al., 2016.

The territory of Armenia and adjacent part of s. Georgia and easternmost part of Turkey, represents one of the densest volcano clusters on the Earth – 774 volcanoes on a territory ~ 50,000 km^2.

In Armenia, within ~30,000 km^2 516 Quaternary volcanoes are mapped, including 4 large stratovolcanoes, several large (mostly monogenetic) volcanic highlands (VH) and 12 rhyolitic domes.

From north to south the following spatial clusters of Pliocene – Quaternary volcanism are identified: Samsari volcanic ridge in South Georgia, Javakheti volcanic ridge, south Georgia/north Armenia, Aragats volcanic province, Tsakhkunyats ridge and Gegham, Vardenis and Syunik volcanic uplands and Kapan zone further south-southeast in Armenia. This post-collisional volcanism extends further to the west to Ararat volcanic massive, Kars-Erzerum plateau and Van volcanic province in Turkey and to the south-east in Iran (Figure 4). In Gegham, Vardenis and Syunik uplands in Armenia and Samsari ridge in Georgia volcanism continued in Upper Pleistocene and Holocene (Karakhanyan et al., 2002).

Considering regional volcanism, it should be mentioned that within the collisional orogenic plateau in the eastern Turkey, the biggest volcanic province is the Erzerum-Kars plateau, bordering to Armenia, with intense collision related volcanism ranging in age from Middle Miocene until the end of Pliocene (Pearce et al. 1990; Keskin et al. 1998), and a series of volcanoes located north of Lake Van (Bingol, Mush, Nemrut, Sipan, Girekol), and further east Tondrak (Tendurek) and Ararat. Two big Quaternary stratovolcanoes are known in the northwest of Iran, namely the Sabalan (4811 m) and the Sahand (3707 m).

Holocene and historical activities have been mentioned for the Nemrut, Tondrak, and Ararat volcanoes in eastern Turkey (Yilmaz et al.,, 1998, Karakhanyan et al., 2002). Mount Nemrut volcano is located near Lake Van (SE Turkey) and is one of the most active and voluminous volcanoes in the entire continental collision zone between Arabia and Eurasia. Historical eruptions of Nemrut volcano are dated back to 1441 AD according to historical observations (in “Memory Notes of Armenian Chronicles” of the 15th century).

Aragats in Armenia is one of the largest stratovolcanoes in the region (4090 m a.s.l). As a result of volcanic activity within the Aragats volcanic area (about 5000 km2), two polygenic stratovolcanoes were formed: Aragats itself and Arailer, as well as 98 monogenic centers on the periphery. Period of activity of Aragats stratovolcano is ranging from 1.54 to ~0.5 Ma (Meliksetian et al., 2014). Quaternary volcanic series of Aragats polygenic volcano are ranging from tracybasalts to tracydacites and exhibit moderate alkaline chemistry. Huge fields of tuffs, tuff-lavas and ignimbrites in Armenia are related to Aragats volcanic region.

Figure 5. Smbatasar Holocene volcano, Vardenis volcanic upland.

Figure 6. Nazeli Holocene volcano, Syunik volcanic highland, south Armenia.

EXCURSIONS PROGRAM

MID-CONFERENCE FIELD TRIPS (2 Days, 16-17 September 2017)

Excursions are planned for 16th and 17th of September from the Institute of Geological Sciences of Armenia. Our buses (with air conditioning) will pick you up from there.

In September weather is usually dry and warm in Armenia but in any case we advise you to have a raincoat. Temperature at the day time is expected to be sunny and around +28°.Please take a sun hat or cap with you. In the evenings the temperature may decrease to +14°, so please take a warm jacket and/or sweater with you.

Mid-conference excursion 1, 16th September, 09.30 AM

1. Matenadaran-Scientific Research Institute of Ancient Manuscripts
2. Lunch break
3. Garni Fortress
4. Azat River Canyon
5. Geghard Monastery
6. Return to Yerevan

Figure 7. Road map of 16th September excursion

First we will visit Matenadaran-Scientific Research Institute of Ancient Manuscripts after Mesrop Mashtots. Matenadaran is a repository of ancient manuscripts, research institute and museum in Yerevan. It holds one of the world's richest depositories of medieval manuscripts and books which span a broad range of subjects, including history, philosophy, medicine, literature, art history and cosmography in Armenian and many other languages.

Afterwards we will visit Garni Fortress and the 1st century AD Classical Hellenistic Temple of Garni. It is located at 28 km away from Yerevan. Then the buses will take a route to the spectacular gorge of the Azat River, which is located at a short distance from the temple and see spectacular columnar joints lava flow and Garni active fault.

After the lunch we will visit the 4th-13th Century AD Geghard Monastery and view of Vokhchaberd volcanoclastic suite of Upper-Miocene-Pliocene Age. Geghard (in Armenian meaning "spear") is a medieval monastery in Kotayk province of the Republic of Armenia, being partially carved out of the adjacent mountain, surrounded by cliffs. The monastery complex was founded in the 4th century by Gregory the Illuminator at the site of a sacred spring inside a cave.

Both Garni and Geghard are located at the foothills of Gegham volcanic ridge in in the central Armenia. That is a typical example of monogenetic (areal) volcanism and presented morphologically by elongated oval shield. The highest point of the Gegham Upland, among 127 known Quaternary volcanic centers, is Azhdahak volcano, 3597 m. Period of activity of Gegham volcanic upland is ranging from Late Miocene (Baghdasaryan&Ghukasyan, 1985) up to Holocene (Karakhanyan et al., 2003). Within the upland Quaternary volcanic activity is presented by volcanic products erupted from monogenic centers varying in composition form: trachybasalts, baslatic-trachyandesites,- trachyandesites to trachytes trachydacites and trachyrhyolites, (Jrbashyan et al., 2007). It is noteworthy, that Vokhchaberd volcanoclastic suite of Upper-Miocene-Pliocene Age is associated with stratovolcano and caldera-style eruptions, while monogenetic (areal) volcanism is overimposed on older formations in Quaternary. Azat is a river in the Kotayk Province of Armenia. Its source is on the western slope of the Gegham volcanic upland. It flows through Garni, towards Ararat valley into the Arax near Artashat. The Azat River is known in Armenia for its beauty. It flows for 55 kilometers and has a basin of 572 square kilometers. The Azat passes through the Khosrov State Reserve. In its lower reaches, the river flows into the Ararat valley. The Azat is known for its numerous spectacular waterfalls and its rock choked river bed. Near Garni the canyon cuts spectacular columnar trachybasaltic andesite lava flow, dated 127 Ka. The source of lava flow is within Gegham volcanic upland. Hexagonal prisms formed in the canyon are related to slow cooling and cracking of lava flow in Armenia. It gotthe name “Symphony of stone” and is recognized as a geological monument. (Figure 8).

Figure 8. (a) and (b) Columnar joint trachybasaltic andesite lava flow in the canyon of Azat River near Garni.

Matenadaran

Figure 9. Matenadaran Scientific Research Institute of Ancient Manuscripts after Mesrop Mashtots.

The Mesrop Mashtots Institute of Ancient Manuscripts commonly referred to as the Matenadaran is a repository of ancient manuscripts, research institute and museum in Yerevan. It holds one of the world's richest depositories of medieval manuscripts and books which span a broad range of subjects, including history, philosophy, medicine, literature, art history and cosmography in Armenian and many other languages.

The earliest mention of the term matenadaran, which means "repository of manuscripts" in Armenian, was recorded in the writings of the 5th century A.D. historian Ghazar Parpetsi, who noted the existence of such a repository at Etchmiadzin Cathedral, where Greek and Armenian language texts were kept. Thousands of manuscripts in Armenia were destroyed over the course of the 10th to 15th centuries during the Turkic-Mongol invasions. According to the medieval Armenian historian Stepanos Orbelian, the Seljuk Turks were responsible for the burning of over 10,000 Armenian manuscripts in 1170 in Baghaberd (Southern Armenia). In 1441, the matenadaran in Sis (Cilician Kingdom of Armenia), was moved to Etchmiadzin and other nearby monasteries. As a result of Armenia being a constant battleground between Turkey and Persia, the Matenadaran in

Etchmiadzin was pillaged several times. Eastern Armenia's incorporation into the Russian Empire in the first third of the 19th century provided a more stable climate for the preservation of the remaining manuscripts. The Armenian cultural workers procured new manuscripts and put them in order with more confidence.

Whereas in 1828 the curators of the Matenadaran catalogued a collection of only 1,809 manuscripts, in 1914 the collection had increased to 4,660 manuscripts. At the outbreak of World War I, all the manuscripts were sent to Moscow for safekeeping and were kept there for the duration of the war.

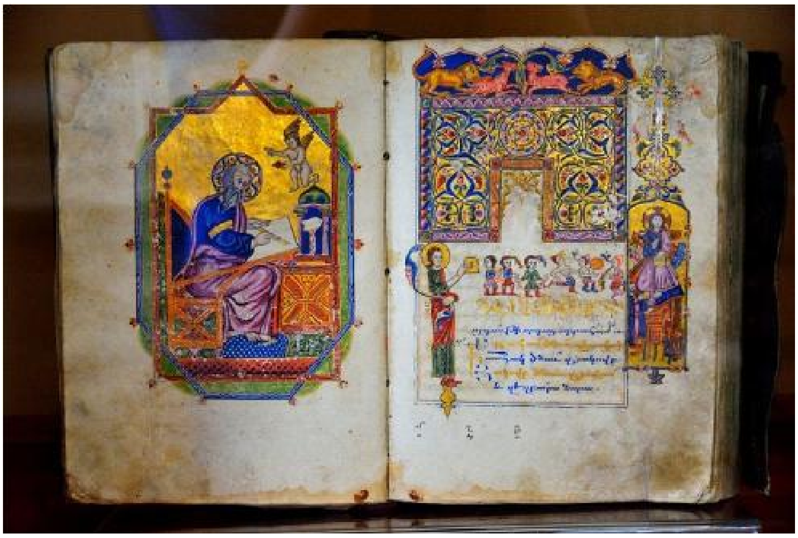

Figure 10. Fragment of medieval manuscript.

In a decree issued by Alexander Miasnikyan on March 6, 1922, the manuscripts that had been sent to Moscow were to be returned to Armenia. Combined with other collections, they were declared a property of the state on December 17, 1929. In 1939, the collection was moved to Yerevan and stored at the Alexander Miasnikyan State Library. Finally, on March 3, 1959, the Council of Ministers of the Armenian Soviet Socialist Republic voted in support of the establishment of a repository to maintain and house the manuscripts in a new building, which was named after Saint Mesrop Mashtots, The Matenadaran was designed by architect Mark Grigoryan. Located slightly north of the city's center at the foot of a small hill, construction began in 1945 and ended in 1957.

The Matenadaran is in possession of a collection of nearly 17,000 manuscripts and 30,000 other documents that cover a wide array of subjects such as historiography, geography, philosophy, grammar, art history, medicine and science. In addition to the Matenadaran's Armenian manuscripts, there is a vast collection of historical documents numbering over 2,000 in languages such as Arabic, Persian, Hebrew, Japanese and Russian. The Armenian collection is also composed of 2,500 Armenian illuminated manuscripts, which include such prominent examples as the Echmiadzin Gospel (989) and the Mugni Gospels (1060). Another prominent manuscript in the collection is the Homilies of Mush, written in the years 1200-1202 A.D. in the Avak Monastery in Yerzenka (modern-day Erzincan, Turkey), which measures 55.3 cm by 70.5 cm (21.8 inches by 27.8 inches), weighs 27.5 kg (60.6 lbs.), and contains 603 calf skinparchment pages. The book was found by two Armenian women in a deserted Armenian monastery in the Ottoman Empire during World War I and the Armenian Genocide period. Since it was found to be too heavy to be carried, it was split into two: one half was wrapped in a cloth and buried, while the second half was taken to Georgia. A couple of years later, a Polish officer found the first half and sold it to an officer in Baku. It was eventually brought to Armenia and the two halves were finally reunited.

The Mashtots Matenadaran Ancient Manuscripts Collection was inscribed on UNESCO's Memory of the World Programme Register in 1997 in recognition of its world significance.

Garni Fortress and Hellenistic temple

Figute 11. Garni Hellenistic temple, 1st century AD.

The fortress of Garni is situated in the village of the same name in the Kotayk Province of Armenia. The settlement has an ancient history, and is best known for the Hellenistic Garni temple. The area was first occupied in the 3rd millennium BC along easily defensible terrane at one of the bends of the Azat River. The fortress of Garni stands on a triangular cape, which dominates the locality and juts into the river. A deep gorge and steep mountain slopes serve as a natural impregnable obstacle, and therefore the fortress wall was put up only on the side of the plain. It was put together of large square-shaped slabs of basalt placed flat on top of each other without mortar and

Figure 12. An overview of Azat river canyon.

fastened together with iron cramps sealed with lead. The evenly spaced rectangular towers and the concave shape of the middle of the most vulnerable northern wall, which increased the effectiveness of flank shooting, added much to the defense capacity of the fortress and, at the same time, enhanced its artistic merits. In the 8th century BC the area (in Urartian: “Country of Giarniani”) was conquered by the Urartian king Argishti the I. In the epoch of the Armenian rulers of the Ervandids, Artashesids and Arshakids dynasties (since the3th century B.C. to the 4th century A.D.), fortification at Garni was a summer residence of the kings and the place where their troops were stationed.The structures of Garni combine elements of Hellenistic and national culture, which is an evidence of antique influences and the distinctive building traditions of the Armenian people.

Figure 13. A fragment of Garni fortress wall.

The palace complex included several disconnected buildings: a temple, a presence chamber, a columned tall, a residential block. a bath-house. etc. They were situated around the vast main square of the fortress, in its southern part, away from the entranceway, where they formed all ensemble. In the northern part, there probably were the premises of the service staff, the king’s guards and the garrison.

The temple was built in the second half of the first century B.C. and dedicated to a heathen god, probably to Mithra (Mihr in Armenian), the god of the sun whose figure stood in the depth of the sanctuary (naos). After Christianity had been proclaimed the state religion in Armenia in 301, the temple was probably used as a summer residence of the kings. A chronicle describes it as ‘‘a house of coolness”. In its style, the temple, a six-column periptere and stands on a high podium with a two-step base and is surrounded with 24 Ionic columns, resembles similar structures in Asia Minor (baths at Sagala and Pergamum), Syria (Baalbek) and Rome. Its architectural shapes are Hellenistic but local traditions also show in it. It should be noted that a rectangle-based religious edifice with columns and a pediment was known on the territory of the Armenian Highland.

Figure 14. Fragments of stone mosaic floor at the bathhouse

The bases of the columns resemble those of Attic temples in their shapes, the shafts are smooth, the Ionic capitals are decorated with clean-cut molded, rather than hewn, volutes and ova and leaf ornaments which differ from column to column — a characteristic feature of Armenian monuments. The shape of the corner capitals is most interesting — on them as distinct from the inside columns, the volutes of the adjacent front sides are turned at a right angle and the floral ornament of the lateral sides are more graceful in their composition. The temple’s proportions differ somewhat from the proportions of other antique structures. Its composition is based on the contrast between the horizontal divisions of the podium and the entablature and the vertical columns, which rose sharply against the background of the sky. The temple makes an impressive sight from many remote and close observation points.

A palace situated to the west of the temple was another edifice distinguished for its artistic merits and size (about 15 by 40 m). Its southern part, a presence chamber 9.65 by 19.92 m, was an oblong premise, its ground floor roofing resting on eight square pillars arranged along the longitudinal axis. The walls were punctuated with pilasters, aligned with the pillars. There were niches between them. The northern part of the palace was taken up by residential quarters. Judging by the fragments that have survived to this day, the composition of the façade of this part, which overlooked the square, had risalitas. The premises of the basement served auxiliary purposes. One of them was a winery, for instance. In one of the rooms, one can see traces of dark-red plastering, which seems to indicate that the residential and presence chambers of the palace were richly ornamented.

The bathhouse is situated in the northern part of the square. At an angle to the residential block. Built in the third century, it comprised no less than five premises serving various purposes, four of which had apses at their end walls.

The first apsidal room from the east was a dressing room, the second one, a cold-water bathroom, the third and fourth ones, warm and hot water bathrooms respectively. The bathhouse had a water reservoir, with a heating room in the basement. The floors were faced with baked bricks covered with a layer of polished stucco. They rested on round pillars and were heated from below with hot air and smoke, which came to the underfloor space from the heater. A notion of the interior decoration can be obtained from the fragments of two-layer plasterwork which survived in several rooms — the white lower layer and the pink upper layer — as well as from the floors with remnants of stone mosaics of 15 hues. Of special interest is the soft-color mosaic of the dressing room floor dating back to the 3rd 4th centuries, an outstanding example of monumental painting in central Armenia. The theme of the mosaic decoration of the 2.91 by 3.14 m floor draws upon Greek mythology. Against the light-green background, representing the sea, there are inlaid pictures of the gods of the Ocean and the Sea, framed with a "wattle" ornament, fishes, Nereids and ichthyocentauri. A wide pink band runs the perimeter of the mosaic. The tonal transitions of the water surface create the impression of wave movement. Greek inscriptions name the deities and Nereids, which are skillfully executed by artisans who obviously had a good knowledge of anatomy. Human figures with faces of Oriental type are depicted in a most specific manner. A Greek inscription over the heads of the gods says: "Worked and gain nothing." The bathhouse of Garni in its composition and in that it had rooms with various temperatures with the hypocaust heating system, has much in common with the antique bathhouses of Syria and Asia Minor, in Dura-Europos and in Antioch on the Orontes (3rd century).

On the fortress grounds, archeologists found fragments of various works of art. Among them, a marble torso of what looks like a man's figure in anitique attire merits special attention. The torso is harmoniously proportioned. The folds of an engirdled tunic draped around a calmly standing figure are well rendered. The figure has much in common with a marble woman's figurine found in Artashat and dating back to the end of the 2nd and the beginning of 1st century B.C. Also well preserved is a great number of superbly executed fragments of column bases, plasters, window and door plathands, cornice stones, etc., which undoubtedly belonged to various monumental buildings. Judging by the remnants, one of these buildings was a four-apse Christian temple of the 7th century built in place of the ruins of the palace's presence-chamber. Numerous structures on the territory of the settlement adjacent to the fortress as well as handicraft articles indicate a high level of Christian art which flourished there in the 4th to the 17th centuries. Timur Lenk eventually sacked the fortress in 1386. In 1679 an earthquake devastated the area destroying the temple. The Hellenistic temple of Garni was reconstructed in 1975.

Geghard Cave Monastry

Geghard (in Armenian meaning "spear") is a medieval monastery in the Kotayk province of Republic of Armenia, being partially carved out in tuffs of the adjacent mountain, surrounded by cliffs. The monastery complex was founded in the 4th century by Gregory the Illuminator at the site of a sacred spring inside a cave. The monastery had thus been originally named Ayrivank (meaning "the Monastery of the Cave"). The name commonly used for the monastery today, Geghard, or more fully Geghardavank. The monastery was famous because of the relics that it housed. The most celebrated of these was the spear which had wounded Christ on the Cross, allegedly brought there by the Apostle Thaddeus, from which comes its present name, Geghard-avank ("the Monastery of the Spear"), first recorded in a document of 1250. This made it a popular place of pilgrimage for Armenian Christians over many centuries. No works of applied art have survived in Geghard, except for the legendary spear (geghard). The shaft has a diamond-shaped plate attached to its end; a cross with flared ends is cut through the plate. A special case was made for it in 1687, now kept in the museum of Echmiadzin monastery. The gilded silver case is an ordinary handicraft article of 17th century Armenia. Now it is displayed in the Echmiadzin treasury.

Figure 15. General view of Vokhchaberd Late Miocene-Early Pliocene volcanoclastic suite cut by canyon of Azat river and Geghard Monastery.

Figure 16. Geghard Monastery.

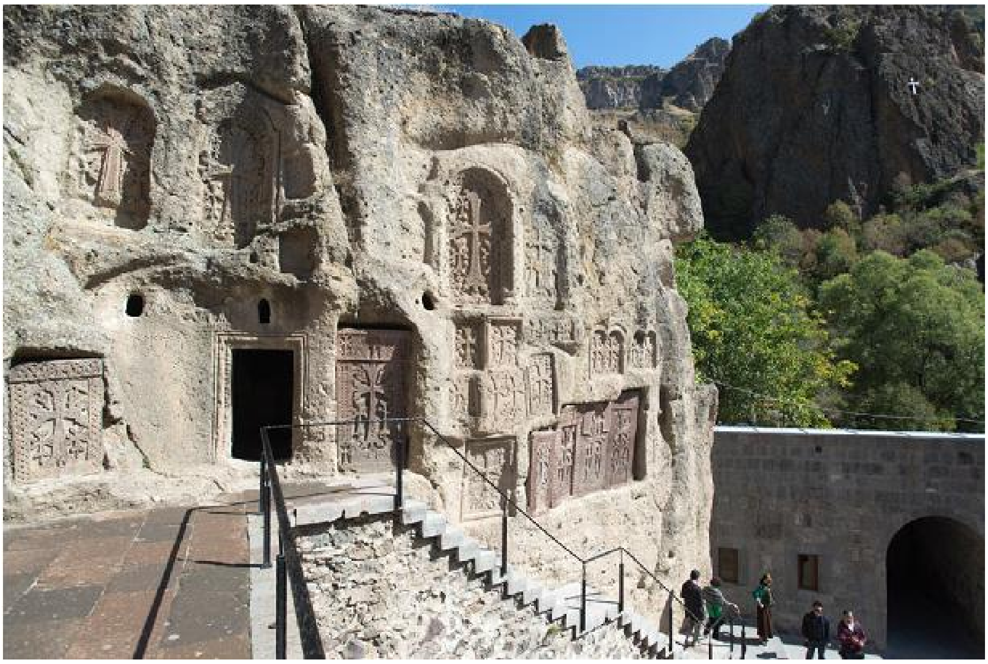

Figure 17. Engraved in tuff cliff and free-standing khachkars (cross-stones).

According to Armenian historians of the 4th, 8th and 10th centuries the monastery comprised, apart from religious buildings, well-appointed residential and service installations. The first monastery was destroyed by Arabs in the 9th century. Ayrivank suffered greatly in 923 from Nasr, a vice-regent of an Arabian caliph in Armenia, who plundered its valuable property, including unique manuscripts, and burned down the magnificent structures of the monastery. Though there are inscriptions dating to the 1160s, the main church was built in

1215 under the auspices of the brothers Zakare and Ivane, the generals of Queen Tamar of Georgia, who took back most of Armenia from the seljuks.

The gavit, partly free-standing, partly carved in the cliff, dates to before 1225, and a series of chapels hewn into the rock dates from the mid-13th century following the purchase of the monastery by Prince Prosh Khaghbakian, vassal of the Zakarians and founder of the Proshian principality. Over a short period the Proshyans built the cave structures which brought Geghard well-merited fame — the second cave church, the family sepulcher of zhamatun (rock-cut church) Papak and Ruzukan, a hall for gatherings and studies (collapsed in the middle of the 20th century) and numerous cells. West of the main temple there is a rock-attached vestry, in Armenian gavit (Latin narthex) built between 1215 and 1225, linked to the main church.

The chamber reached from the North East of the gavit (the vestry) became Prince Prosh Khaghbakian's tomb in 1283. The adjacent chamber has carved in the rock the arms of the Proshian family, including an eagle with a lamb in its claws. A stairway W of the gavit leads up to a funerary chamber carved out in 1288 for Papak Proshian and his wife Ruzukan. The Proshyan princes provided Geghard with an irrigation system in the 13th century. At this time, it was also known as the Monastery of the Seven Churches and the Monastery of the Forty Altars. All around the monastery are caves and khachkars. The monastery was defunct, the main church used to shelter the flocks of the Karapapakh nomads in winter, until resettled by a few monks from Etchmiadzin after the Russian conquest.

Some of the churches within the monastery complex are entirely dug out of the cliff rocks, others are little more than caves, while others are elaborate structures, with both architecturally complex walled sections and rooms deep inside the cliff. The combination, together with numerous engraved and free-standing khachkars is a unique sight, being one of the most frequented tourist destinations in Armenia. Restored for tourist purposes but now with a small ecclesiastical presence, the site is still a major place of pilgrimage.

The spectacular towering cliffs exposed in Azat River gorge surrounding the monastery are parts of Vokhcaberd volcanoclastic suite of Late Miocene-Early Pliocene age, and are included together with the monastery in the World Heritage Site listing.

Mid-conference excursion: Day 2, 17th September,10.30 AM

1. National Academy of Sciences of Armenia, 10.30 AM
2. State History Museum of Armenia
3. Lunch break
4. Holy Hripsime Church of the 7th Century AD
5. Etchmiadzin Cathedral (est. 4th Century AD)
6. Return to Yerevan

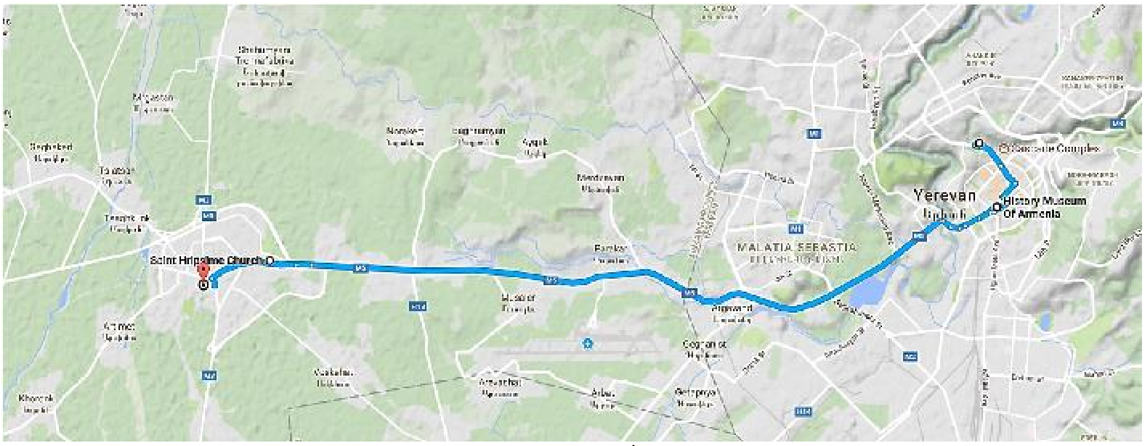

Figure 18. Road Map of 17th September excursion.

On this day our excursions will be carried out both in Yerevan and Vagharshapat town. First we will visit State History Museum of Armenia which is located in the center of the capital. The excursion in the Museum will cover several departments, such as archeological, medieval and etc. Next we will take a journey to Vagharshapat town and see and Hripsime 7th Century AD church andEtchmiadzin Cathedral (est. 4th Century AD) - center of the Armenian Apostolic Church. Theroad goes through Ararat valley that represents intermountain depression. Ararat depression is located between Aragats and Ararat volcanoes and Gegham volcanic ridge, represents a large and complex pull apart structure (Karakhanyan et al., 2004, Dewey et al. (1986), Yilmaz et al. (1998). Taking into account a wide distribution of volcanism within the Ararat valley and in its suburbs, one can come to a conclusion that this valley is represented as a complex volcanotectonic structure.

History Museum of Armenia

The History Museum of Armenia was founded in 1919 but was opened to the public only two years later, on August 20, 1921. The museum was initially formed relying of collections of the Armenian Ethnographical Association of the Caucasus, Nor Nakhidjevan Museum of Armenian Antiquities, Museum of Antiquities of Ani and Vagharshapat Repository of Ancient Manuscripts.

Since its establishment, it has been named differently. Back in 1920s, it was known as the State Central Museum of Armenia, in early 1930s as the Cultural-Historical Museum, while in middle 1930s as just the Historical Museum. In 1935, a decision to establish two separate museums was made. The decision was due to the museum's collection, and as a result, the present day National Gallery of Armenia with 1660 objects and the present day Museum of Literature with 301 objects and 1298 manuscripts were formed. In 1962 was named the State History Museum of Armenia and from that day up to the year 2003 it was known as so. The museum acquired its present day official name in 2003, which goes as follows "History Museum of Armenia".

Figure 19. Golden-bowl of Vanadzor (20-18 cc. BC).

The History Museum of Armenia gives a thorough picture of the ancient times. In line with that, Armenian Highland's culture from pre-historic times up to the present days is introduced. The museum's collection is beyond a doubt a rare one with traces of such western and eastern countries in the Armenian Highland as Egypt, Hittite Empire, Mitanni, Assyria, Babylonia, Achaemenes, Byzantine Empire and so forth.

3rd-2nd millennia BC bronze specimens (ceramic ware, stone molds, weapons, attributes of power, statuettes, cylindrical seals, gold, silver, bronze and glass jewelry are presented in the museum. Other than that, the museum features the following treasures: ancient evidences of the history of transport, 15th-14th century BC wooden carts and chariots, excavated from Lchashen, cuneiform inscriptions, wall-paintings, red-polished ceramics, unique specimens of gold and silver from the powerful state of Biainili - Urartu (Van Kingdom), specimens of transformation of the Hellenistic culture in Armenia, excavated from the archeological sites of Garni, Artashat and Oshakan, Miletian, Greek-Macedonian, Seleucid, Parthian, Roman, Sassanid, Byzantine, Arabic, Seljuk and other gold, silver and copper coins, circulating in Armenia.

Figure 20. 15th-14th century BC wooden chariots excavated from Lchashen

Figure 21.Silver coin of TigranII the Great (95-55 cc. BC)

Coins of the Armenian Artaxiad dynasty (189 BC – 6 AD), architectural, sculptural and ceramic findings from the Medievel Armenian cities of Dvin, Ani and from the fortress of Amberd. Coins of the of the Kiurike kingdom (11th century) and Armenian kingdom of Cilicia (1080-1375), medieval Armenian inscriptions, khachkars (Cross-stones) etc.

The museum has published a number of significant works particularly regarding Armenian architecture, ethnography, history and of course archaeological excavations. Now the museum includes more than 400,000 objects presented in four departments: archaeology, ethnography, numismatics and documents.

Etchmiadzin Cathedral

Etchmiadzin Cathedral is the mother church of the Armenian Apostolic Church, located in the city of Vagharshapat (Etchmiadzin), in Armavir marz of Republic of Armenia. According to scholars, it was the first Christian cathedral built in ancient Armenia, and is considered the oldest cathedral in the world.

According to tradition, the cathedral was built by Armenia's patron saint Gregory the Illuminator between 301 and 303 near the royal palace in then Armenian capital city of Vagharshapat, on the location of a pagan temple. According to the V century Armenian historian Agathangelos, Saint Gregory the Illuminator had a vision Jesus Christ descending from heaven and striking the earth with a golden hammer to show where the cathedral should be built. Hence, the patriarch gave the church the name of Ejmiadzin, which translates to "the Descent of the Only-Begotten [Son of God]."

Figure 22. Mother See of Holy Etchmiadzin

The Kingdom of Armenia under Tiridates III became the first country in the world to adopt Christianity as a state religion in 301. According to Faustus of Buzand, the cathedral and the city of Vagharshapat were almost completely destroyed during the invasion of Persian King Shapur II in 363. Due to Armenia's bad economic conditions, the cathedral was renovated by Catholicos Nerses the Great (353–373) and Sahak Parthev (387–439) only urgently and partially. In 387, Armenia was partitioned between the Roman Empire and the Sassanian Empire.

The eastern part of Armenia where Etchmiadzin was located remained under the rule of Armenian vassal kings subject to Persia until 428, when the Armenian Kingdom was dissolved.

By the last quarter of the V century, the cathedral was dilapidated. According to Ghazar Parpetsi, it was rebuilt from the foundations by marzpan (governor) of Persian Armenia Vahan Mamikonian in 483-484, when the country was relatively stable, following the struggle for religious freedom against Persia. Most researchers have concluded that, thus, the church was converted into cruciform church and mostly took its current form. The new church was very different from the original one and "consisted of quadric-apsidal hall built of dull, grey stone containing four free-standing cross-shaped pillars disdained to support a stone cupola." The new cathedral was "in the form of a square enclosing a Greek cross and contains two chapels, one on either side of the east apse."

During archaeological excavations at the cathedral in 1955–56 and 1959, led by architectural historian Alexander Sahinian, remains of the original IV century building were discovered – including two levels of pillar bases below the current ones and a narrower altar apse under the present one. Based on these findings, Sahinian asserted that the original church had been a three-naved vaulted basilica. From its foundation until the second half of the V century, Ejmiadzin was the seat of the Catholicos, the supreme head of the Armenian Church.

Although never losing its significance, the cathedral subsequently suffered centuries of virtual neglect. In 1441, it was restored as catholicosate and remains as such to this day. Since then the Mother See of Holy Etchmiadzin has been the administrative headquarters of the Armenian Church. The Safavids plundered Etchmiadzin in 1604, when relics and stones were taken out of the cathedral to New Julfa in an effort to undermine Armenians' attachment to their land. Since then the cathedral has undergone a number of renovations. Belfries were added in the latter half of the XVII century and in 1868 a sacristy was constructed at the cathedral's east end. Today, it incorporates styles of different periods of Armenian architecture. Diminished during the early Soviet period, Etchmiadzin revived again in the second half of the XX century, and under independent Armenia.

In 2000, Etchmiadzin underwent a renovation prior to the celebrations of the 1700th anniversary of the Christianization of Armenia in 2001. In 2003, the Armenian Church celebrated the 1700th anniversary of the consecration of the cathedral. Catholicos Garegin II issued a pontifical encyclical on January 30. On February 3 he declared 2003 the Year of Holy Etchmiadzin. As the main shrine of religious Christian Armenians worldwide, Etchmiadzinhas been an important location in Armenia not only religiously, but also politically and culturally. A major pilgrimage site, it is one of the most visited places in the country.

Along with several important early medieval churches located nearby, the cathedral was listed as a World Heritage Site by UNESCO in 2000.

Saint Hripsime Church

Saint Hripsime Church is a seventh century Armenian Apostolic church in the city of Vagharshapat (Etchmiadzin), Armenia. It is one of the oldest surviving churches in the country. The church was erected by Catholicos Komitas to replace the original mausoleum built by Catholicos Sahak the Great in 395 AD that contained the remains of the martyred Saint Hripsime to whom the church is dedicated. The current structure was completed in 618 AD. It is known for its fine Armenian-style architecture of the classical period, which has influenced many other Armenian churches since. It was listed as a UNESCO World Heritage Site along with other nearby churches, including Etchmiadzin Cathedral, Armenia's mother church, in 2000.A Hellenistic temple, similar to the Temple of Garni and dedicated to a pagan goddess, stood in the place of the church. During excavations in 1958 the foundation of a monumental stone building with Hellenistic ornaments was found under the supporting column.

Figure 23. Saint Hripsime church (7th Century AD)

Hripsime, along with the abbess Gayane and thirty-eight unnamed nuns, are traditionally considered the first Christian martyrs in Armenia's history. They were persecuted, tortured, and eventually killed by king Tiridates III of Armenia. According to the chronicler Agathangelos, after conversion to Christianity in 301, Tiridates and Gregory the Illuminator built a martyrium dedicated to Hripsime at the location of her martyrdom, which was half buried underground. Excavations around the church have uncovered remains of several tortured women buried in early Christian manner, which, according to Agop Jack Hacikyan et al., "seem to support the story of Agathangelos.

In 395 Patriarch Sahak Partev (Isaac the Parthian) rebuilt or built a new martyrium, which had been destroyed by the Shapur II of the Sasanian Empire in the 360s.

The current building was erected during the reign of Catholicos Komitas (615–628), according to an account of contemporary chronicler Sebeos and two inscriptions, one on the west facade and the other on the east apse. It replaced the earlier mausoleum of Hripsime. The church is suggested by scholars to have been completed in 618.

POST-CONFERENCE FIELD TRIPS(4 DAYS, 18-21 SEPTEMBER)

Post-conference field trip, Day 1, 18th September: Start time 09.00 AM

1. National Academy of Sciences of Armenia 09.00 AM
2. Aragats volcano and Armenian ignimbrites (650 Ka)
3. Lunch break in Talin
4. Arteni obsidian volcano (1.5 Ma)
5. Barozh mid-late Paleolithic open air site and obsidian workshop
6. Gyumri

Figure 24.Road Map of 18th September excursion.

Aragats volcano and Armenian Ignimbrites

Short stop at the foothills of Quaternary Aragats volcano. Aragats (4090m) is one the largest volcanoes in the entire region and produced central vent (inc. Plinian VEI>4) and monogenetic type flank eruptions and periphery plateaus within a total area greater than 5000 km^2, known as Aragats volcanic province (AVP). The Aragats volcanic province (AVP) comprises the composite cone of Aragats volcano, the peak of which is built on a summit plateau, ~45 km in

Figure 25. Aragats stratovolcano, 4090 m. a.s.l. last central vent and flank activity ~500 Ka

diameter shield structure with dozens of flank vents, scattered monogenetic cinder cones on the adjacent volcanic plateaus as well as the neighboring stratovolcano Arailer. Huge fields of lava flows, ranging in composition from basalts to dacites as well as ignimbrite forming plinian eruptions in Armenia are related to Aragats volcano. New K-Ar and $^{40}Ar/^{39}Ar$ age determinations of groundmass and separated plagioclase samples indicate that volcanism at AVP began ~2.5 Ma, while most recent volcanic activity is 0.49 Ma for Plinian eruption of trachydacites from Irind flank vent and basaltic trachyandesite lava flows from Tirinkatar (0.48-0.61 Ma), Kakavasar, (0.52-0.54 Ma) and Ashtarak (0.58 Ma) monogenetic flank centers, as well as trachyandesites of

Figure 26. The highest northern summit of Aragats stratovolcano (4090 m. a.s.l.)

Jrbazhan volcano on the summit plateau of Aragats (0.52 Ma). Activity of Aragats stratovolcano itself is estimated to be around 1 Ma, between 1.54 Ma to ~0.5Ma.

Voluminous Quaternary ignimbrites in Armenia are sourced from Aragats volcano. Based on geological data and petrography, the Armenian ignimbrites can be subdivided into 3 main groups: 1) the welded ashy-tuffs of Yerevan-Leninakan type, 2) the “flame” tuffs of Shamiram-Byurakan type (650 Ka), and 3) the welded ignimbrites of Artik type. First two types have ash matrix and are distinguished from each other by the degree of welding and fiamme content, and relative abundances of vitro and crystal clasts, among other features. Artik tuffs are characterized by distinct eutaxitic (flow) textures and their low vitroclast content.

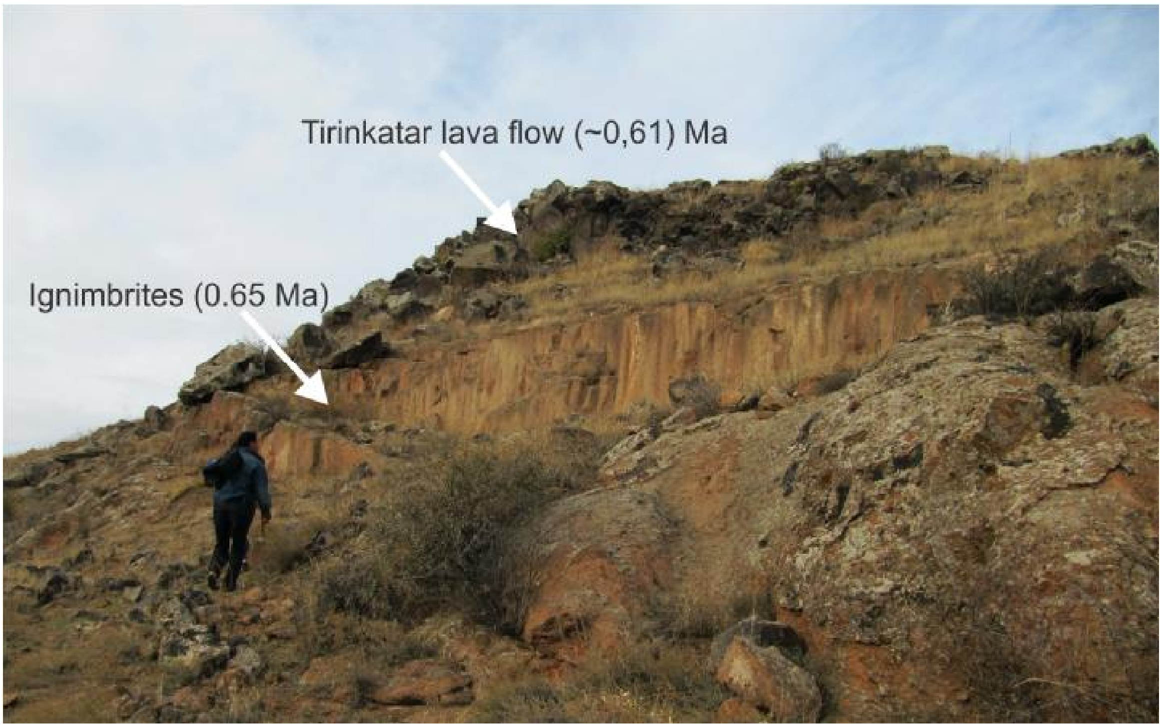

Figure 27. Ignimbrites of Byurakan-Shamiram type, covered by Tirinkatar trachybasaltic andesite lava flow.

It is noteworthy, that abundant tuffs and ignimbrites of the territory of historical Armenia were used since prehistoric, Urartian times as building stone and later since early Christian times (4 c. AD) as building stones for hundreds of cathedrals, and monasteries. Up to present days ignimbrites are widely used as building and facing stones in the cities of Armenia. Cooper, (2010), suggests recognizing Armenian ignimbrite as one of “Global Heritage Stones”, due to rich historical, cultural and architectural context of usage of ignimbrites in Armenia.

Arteni rhyolite (obsidian) volcano

Obsidian is a naturally occurring volcanic glass with vitreous luster. It is a massive glassy form of felsic, silica-rich volcanic rock called rhyolite, which usually contains 70-79% of silica oxide (SiO_2). The name comes from Latin Obsidianus lapis, “Obsidius’ stone”; according to Pliny the Elder, the rock was discovered in Ethiopia by a certain Obsidius, (or more accurately, Obsius). The Armenians call obsidian “devil’s claw” or “vanakat” – from Van, by the name of Lake Van.

Obsidian exhibits wide diversity of colors – it appears black, red, brown, gray, sometimes white and transparent, stripped varieties containing stripes of different colors are also common. Red or black colors of obsidian are related to oxidation state of iron in minerals impurities: reddish and brown are related to trivalent iron ion, black color is typical when bivalent iron is prevailing.

Silvery, whitish and pearl obsidians are related to abundant presence of microscopically visible water-gas inclusions (bubbles). Transparent smoky-quartz-like variety is almost homogenized, degassed glass with very low content of mineral inclusions and bubbles.

Due to its properties to give extremely sharp edges when it breaks,obsidian was utilized widely by man in prehistory, since at least 150,000 years before present from Palaeolithic times up to early Middle Ages. Obsidian was used to

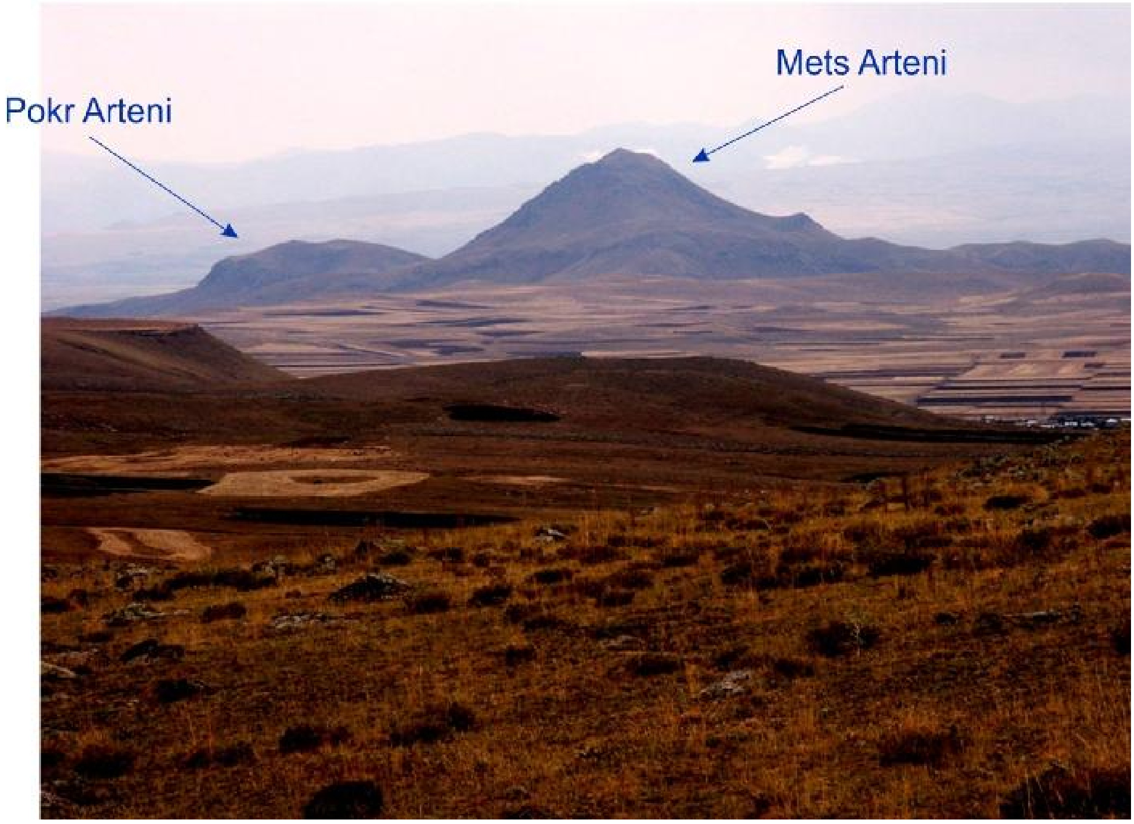

Figure 28. Arteni volcanic complex in Armenia, Aragats volcanic province.

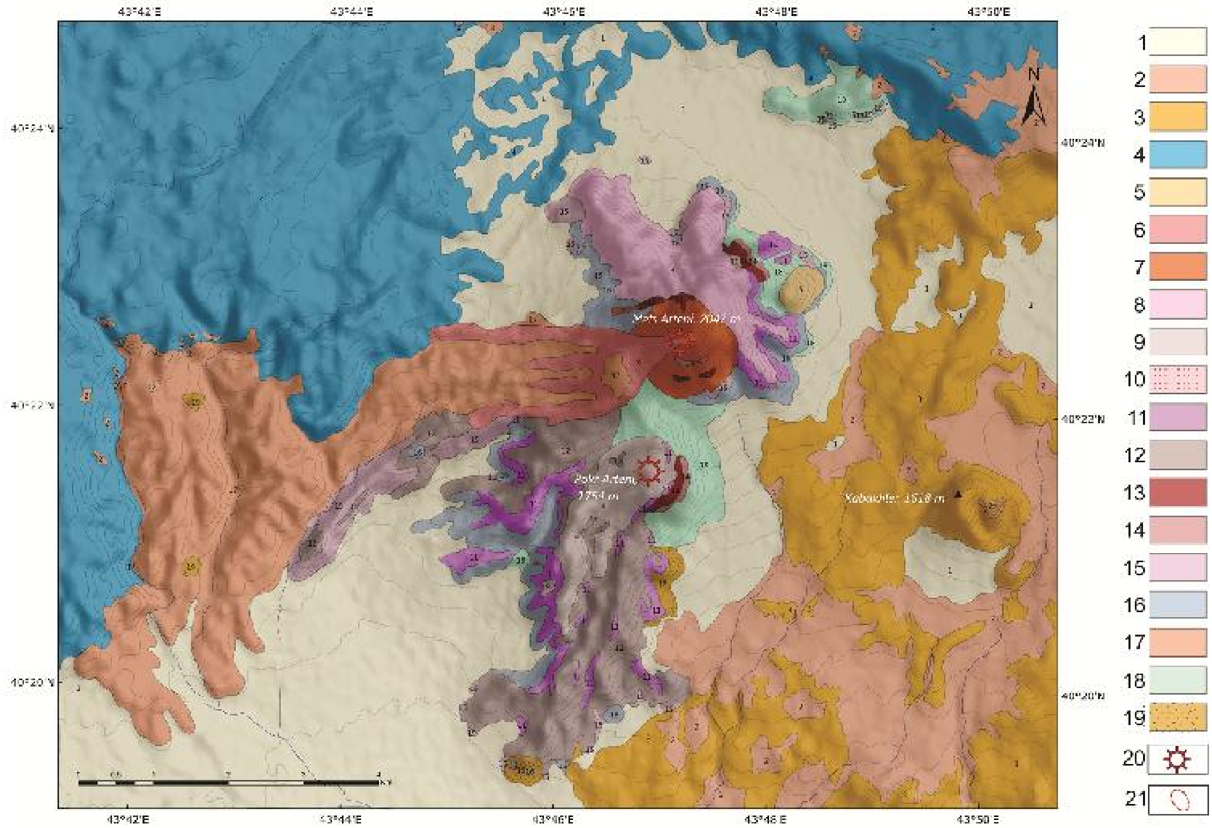

Figure 29. Geological map of Arteni volcanic complex (after Karapetyan, 1972, modified by Kh. Meiksetian and G.Navasardyan)
1. Alluvia, diluvia, eluvia, proluvia deposits; 2. Middle Pleistocene: Tuffs of Yerevan-Leninakan type; 3. Basaltic trachyandesites lava flow; 4. Dacite lavas; Early Pleistocene: Products of Arteni complex (5-20): 5. High silica dacite Tapak blur dome; 6. Rhyolitic lavas upper unit; 7. Rhyolites of Khcan dome; 8. Rhyolites lava flows and lavabreccia of Mets Arteni volcano; 9. Rhyolites lava flows of Pokr Arteni volcano; 10. Rhyolitic tuffs; 11. Rhyolitic lavas – middle unit; 12. Perlite - obsidian lavas and lavabreccia of Pokr Arteni volcano; 13. Perlite extrusion; 14. Perlite eruptive breccia; 15. Rhyolitic lavas – “lower”: glassy and crystallized; 16. Perlite – obsidian tuffs and tuff-breccia; 17. Perlite, pumice agglomerate Aragats flow; 18. Perlite, pumice explosive loose formation; 19. Obsidians; 20. Small dome-shaped, necks and centers of perlite and rhyolite eruption lavas and breccias.

make various tools (knives, axes, scrapers, arrowheads, spearheads etc.) in Stone Age, before the invention of metals.

Arteni volcanic complex (Figure 28) is located within Aragats volcanic province; the age of Arteni rhyolites considered to be early Pleistocene, K-Ar ages yielded: for Mets Arteni 1.45-1.5 Ma (Chernishev et al. 2002), fission tracks (1.27 Ma) Oddone et al. 1999, and 1,26 for Pokr Arteni, (Lebedev et al, 2011). Thus, rhyolitic eruptions and formation of domes of Arteni volcano correspond to Early Pleistocene. Eruption products of Arteni volcano are covered by more recent middle Pleistocene andesitic lava flows of neighboring Kabakhler cinder cone and ignimbrites of Aragats stratovolcano.

Figure 30. Obsidian cliff in small modern quarry across a lava flow erupted from Pokr Arteni volcano.

Arteni is the most complex rhyolite volcano in Armenia, and consists of two independent rhyolite volcanoes, namely Mets (Big) Arteni (2047m) and Pokr (Little) Arteni (1754 m). Arteni obsidian is of a high quality; “smoky quartz” like translucent, reddish-brown and black varieties and dozens of sub-varieties described in detail by (Karapetyan 1972) are known. Geological map of Arteni volcano is presented at Figure 29.

It is noteworthy that Arteni is one of the biggest sources of obsidian in the region that has been widely utilized in prehistoric times (Badalyan et al., 2004, Blackman et al., 1999, Meliksetian et al., 2010). Eruption products consist of rhyolitic and perlitic lava flows, tuffs, and pyroclastic deposits with obsidian. A significant feature is appearance of up to 7-8 km rhyolite - obsidian flow extending from Arteni to the west and a shorter one, about 3 km flowed to the south, which is an indication of high temperature of eruptions and relatively low viscosity of the melt, as usually acid lava, in contrary to basaltic and basaltic andesite lavas, is too viscose to flow for such a long distances and usually forms short flows (up to few hundred meters) or domes and extrusions as well as coulee type flows also called dome flows. Karapetyan et al. 2001, describes several eruption episodes: explosive eruptions of rhyolite pumice and perlite pyroclastics, eruptions of several generations of zonal rhyolite - obsidian and obsidian lava flows, and emplacement of extrusives forming domes. The latest episodes of volcanic activity are marked by emplacement of an extrusive named Khcan (Cork) plugged the conduit of Metc Arteni volcano and formation of small extrusive named Tapak blur (Flat hill). Earlier geochemical studies by Karapetyan and Meliksetian 1972, Keller et al. 1994 and Blackman et al. 1998, Karapetyan et al. 2001 notice, that in spite of geographic and age proximity, obsidian samples from Mets and Pokr Arteni are geochemically different enough to be distinguished as separate sources.

Barozh Middle Paleolithic open air site and obsidian workshop

The newly discovered site of Barozh 12 open air Middle Paleolithic site was studied recently by the international archaeological team, summarized in Glauberman et al., (2013). It is located in western Armenia, near to Arteni volcano. The site yielded significant data on Late Middle Paleolithic technology, land use, and lithic economy in a region that has heretofore been little explored. The lithic assemblage appears similar to those from other later Middle Palaeolithic sites in the region and could date to the time range when archaic and anatomically modern species populations overlapped temporally and/or geographically.

Barozh 12 is a large, high density Middle Paleolithic site. The surface of a 1m×1m unit, and a 0.50m × 0.50m × 0.95m deep test trench yielded 1174 artifacts. Based on preliminary analysis of samples from the surface (n = 102) and excavated artifact assemblages (n = 340), both display typo-technological characteristics of the Middle Palaeolithic in the region. Both discoidal and triangular Levallois core reduction are observed on discarded cores and flakes, as are numerous retouchedpieces, predominantly classified as points, blades, and a variety of unifacial scrapers. Surface and excavated artifacts are of all size classes and technological categories, including tool re-sharpening flakes and core trimming elements. Artifacts class frequencies and cortex analysis also suggest that all stages of core reduction and tool use, maintenance and discard occurred on site. Preliminary results of portable X-Ray fluorescence (pXRF) on a small sample of obsidian artifacts (mainly retouched pieces) indicate that most were manufactured from local (1-2km) Pokr and Mets Arteni material, while a smaller number of artifacts were manufactured on material that originates from 80km –>100km away. Varying frequencies of local and ‘imported’ raw materials observed in small samples from stratified archaeological levels suggests dynamic raw material transport patterns over time. The

Figure 31. View of Barozh open-air Paleolithic site and test trench. Arteni volcano is in the background.

extent of a ‘raw material exploitation territory’ is suggested by obsidian sourcing though only to the east of the site. Further pXRF study of obsidian raw materials in conjunction with further analysis of artifact manufacture and discard patterns, will elucidate regional-scale technological and land use behavior. These first results of survey, lithic assemblage analysis, and test excavation indicate that Barozh 12 was frequently reoccupied over time for a variety of uses, and may be considered a ‘central place’ is the regional settlement and mobility system.

Figure 32.Artifacts from the test trench at Barozh12 (After Glauberman,et al., 2013).

Post-conference field trip, Day2, 19th September: Start time 09.00 AM

19th September: Gyumri– Spitak-Vanadsor-Dilijan-Tsakhkadsor (stay in Tsaghkadsor)

1. Gyumri
2. Scarp of Spitak 1988 earthquake
3. Lunch break
4. Agstev River valley, Vanadsor segment of Pambak-Sevan-Syunik active fault
5. Dilijan,
6. Haghartsin Monastery
7. Tsaghkadsor

Figure 33. Road Map of 19th September excursion.

Scarp of the 1988 Spitak earthquake (M_w 6.9)

The social shock caused Spitak earthquake of 7 December 1988, M_w 6.9, (more than 25,000 people died) forcedcomplete reconsideration of common seismotectonic knowledge in Armenia and its surroundings and practice in many aspects, including critical reevaluation of the techniques and organization of the studies of active faults, earthquake geology, and seismic hazard assessment that had been applied earlier.

Figure 34. Buildings destroyed by 1988 earthquake in Spitak.

Prior to the 1988 Spitak earthquake, seismic hazard studies in Armenia were mainly focused on the analysis of instrumental and partly historical earthquake catalogues primarily by seismologists and geophysicists (Pirouzyan, 1972; Nazaretyan, 1984; Karapetyan, 1988). Active fault studieswere not conducted, and rare monographs addressing issues of seismotectonics were published by specialists in regional geology and stratigraphy (Vardanyants, 1935; Paffenholtz, 1948; Gabriyelyan et al., 1981). Evidence available from the Armenian historical chronicles was mostly ignored because it was considered that chroniclers severely exaggerated damage and casualties caused by earthquakes (Pirouzyan, 1972). The prevailing thought was that strong earthquakes accompanied by surface ruptures were unlikely in the Greater and the Lesser Caucasus (Borisov, 1982). This attitude, as well as social reasons, contributed to severe underestimation of the magnitude and frequency of seismic hazards, both for the Spitak earthquake area, and for Armenia and the Caucasus as a whole. Each of the nine strong earthquakes that occurred in the former USSR from 1948 to 1995 fell in the areas where earthquakes had been estimated to be of much lower seismic hazard. Such inadequate hazard assessments generally contributed to unpreparedness, lack of

Figure 35. Location of the Excursion to the 1988 Spitak Fault.

studies, and high numbers of casualties. The Spitak earthquake has become a tragic lesson for Armenia but also an impetus for modern studies on active tectonics,seismotectonics, and paleoseismology in the country.

The 7 December 1988 Spitak earthquake occurred on the northern most extension of the Garni fault where it joins the northe astern segment of the Pambak-Sevan-Syunik fault system.

Figure 36. 37 km-long surface rupture of Spitak earthquake of December 7, 1988.

Figure 37. The erosion over the last 10 and 20 years after the 1988 Spitak earthquake.

PSSF active fault, Agstev river valley

Vanadzor depression of 16 km long and up to 3 km wide situated in the overstep zones of the 90-km-long Arpi–Vanadzor and the 115-km-long Vanadzor–Artanish segments between the mountain range of Bazum to the North and that of Pambak to the South. The western half of this depression is occupied by the Vanadzor city (the third city of Armenia). Horizontal slip rate estimates are 3–4 mm/year for the Arpi–Vanadzor segment (Trifonov et al., 1990) and 2.8 mm/year for the Vanadzor–Artanish segment (Philip et al., 2001).

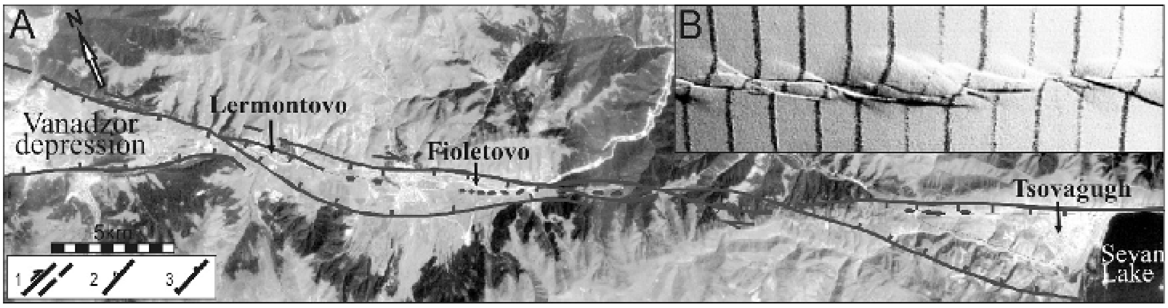

Figure 38. System of active faults forming tectonic depressions proposed by A.Karakhanyan (A). B- Physical experimental model results on sand realized by J.Ritz (Montpellier II University, France) for the strike-slip fault. 1- strike-slip faults, 2- reverse faults, 3- normal faults

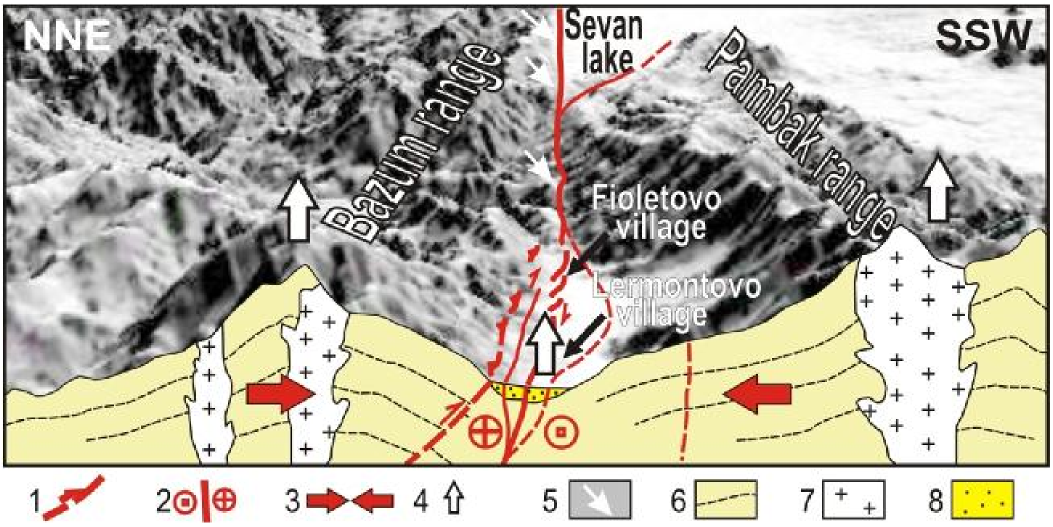

Figure 39. Schematic cross sections throw Tandzut river upstream area (near the Lermontovo village)(Avagyan, 2009). 1- Reverse fault (with unclear activity), 2- active dextral strike-slip fault, 3- Compression axes, 4- local uplift, 5- arrows indicating fault zone, 6- Upper Cretaceous and Paleogene formations, 7- intrusive rocks, 8-Quaternary formation

The PSSF (Pamak-Sevan-Sunik fault) in the Vanadzor depression is subdivided into several branches controlling almond-shaped basin. The depression substratum composed by sedimentary rocks of Eocene and Upper Cretaceous (limestones, tuffs, tuffo-breccia, sandstones) and post Oligocene intrusive rocks

(Sayadyan, 2009). More recent sediments of clay and sand occupy the bottom of the depression and attain 145 meters thickness. Two volcanic levels of tuff acknowledged in borehole in depth of 16.7m and 23.8m in the NW of the basin (Milanovski, 1968). In geological construction of the depression the existence of andesitic basalts (Bagdasaryan and Jrbashyan, 1970) is important from geodynamical point of view which disappear westward under the Pambak river recent alluvium.

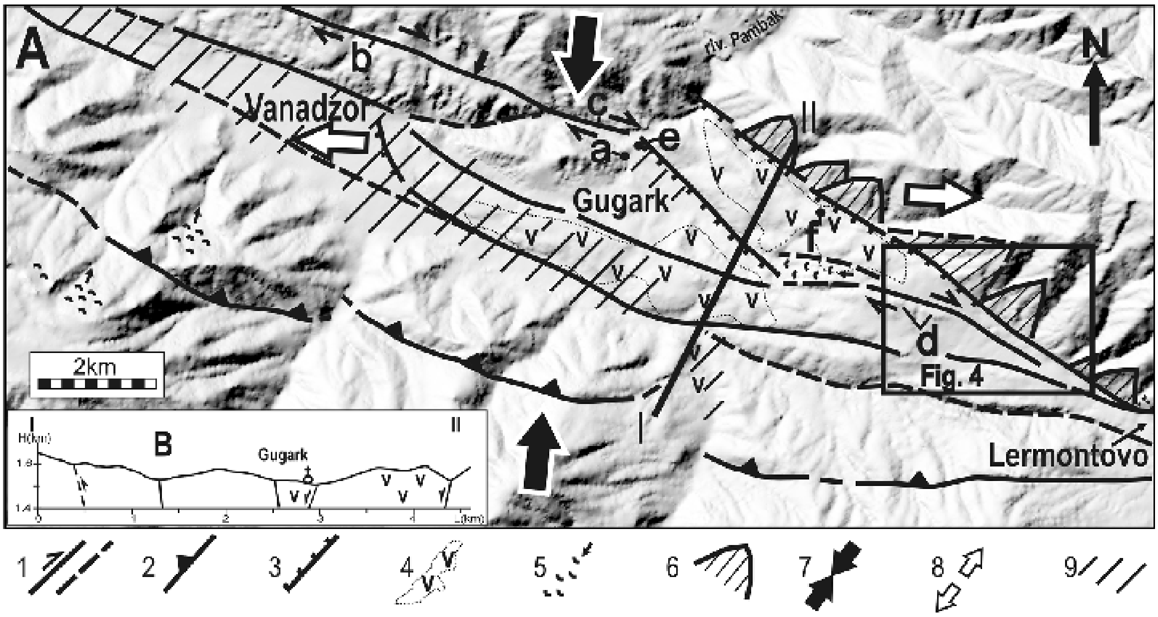

Figure 40. A-Active fault map superposed on the 3D topographic model (Avagyan, 2009; 2010). 1- active and inferred strike-slip faults, 2-reverse faults, 3-normal faults, 4-basalte andesitic, 5 – landslides, 6-triangular facets, 7- regional compression axes, 8-local extension of Right bend, 9- peopled area. B- topographical profile (the I-II line of profile is shown on numerical model) with vertical exaggeration, faults and basalts andesitic situation are shown.

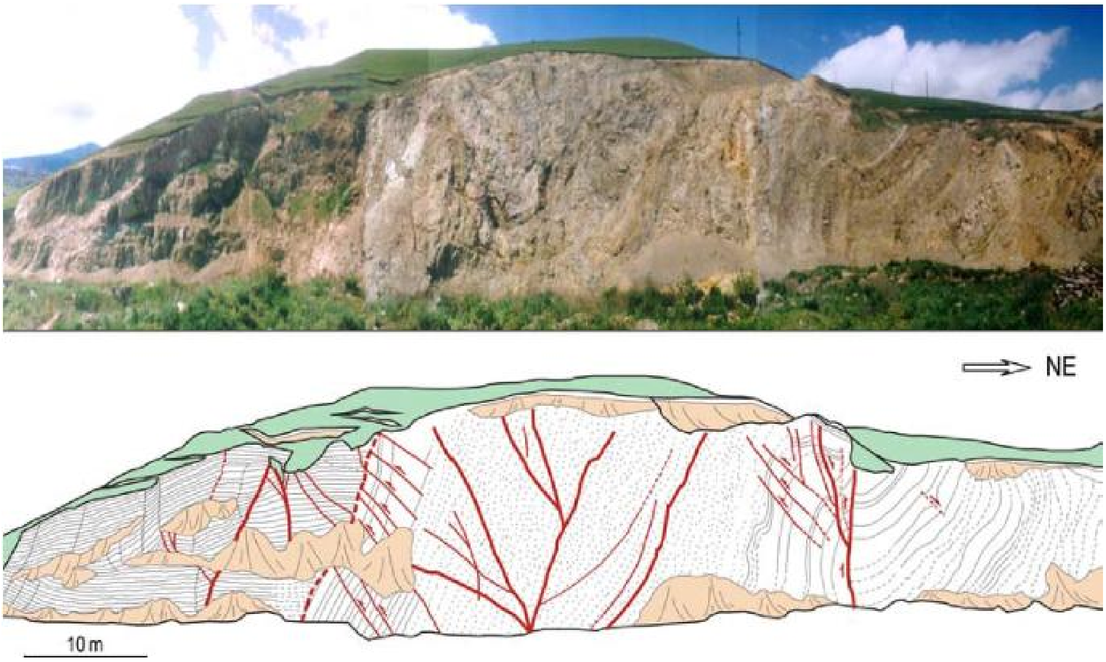

Figure 41. The outcrop to the east of Vanadzor trough in Middle Eocene formations where the pre-existing reverse faultingand younger flower structures of strike–slip fault are distinguished. (Avagyan, 2001; 2010).

Figure 42. Photo of the south slope of the Bazoum range to the East of Vanadzor depression. The fault traces are indicated by arrows.

Two of the selected sites, Fioletovo and Semionovka, respectively, are located within the Vanadzor–Artanish segment of the fault zone. The over-stepping fault segment creates three major jog-type structures with their inner parts depressed in theareas of the towns of Vanadzor, Fioletovo and Tsovagukh along the western bay of the Sevan Lake.

Satellite images and air photos show a system ofelongated ridges in a dextral en e´chelon pattern along the axis of the Fioletovo depression. These ridges clearly appear as scarps on topographic maps and in the field. The ridge axes have an average length of between 100 and 1500 m, while minor ridgeshave axis lengths of 30–500 m. The ridge heights varybetween 5–6 and 30–50m. A similar system of ridges, interpreted as pressure ridges, can also be identified inthe Vanadzor depression, as well as in the northern boundary and the central part of the Sevan depression.

In many cases, the ridge flanks are very steep (50_–60_) and show well-preserved evidence for youngscarps.

In the Semionovka site, elongated ridges located along the trace of the PSSF are interpreted as counter slope scarps associated with south-dipping reverse faults. The length of the ridge axes varies between 50 and 800 m. The misalignment of thalwegs suggests a dextral displacement, which is consistent with the oblique dextral movement observed on thefault plane.

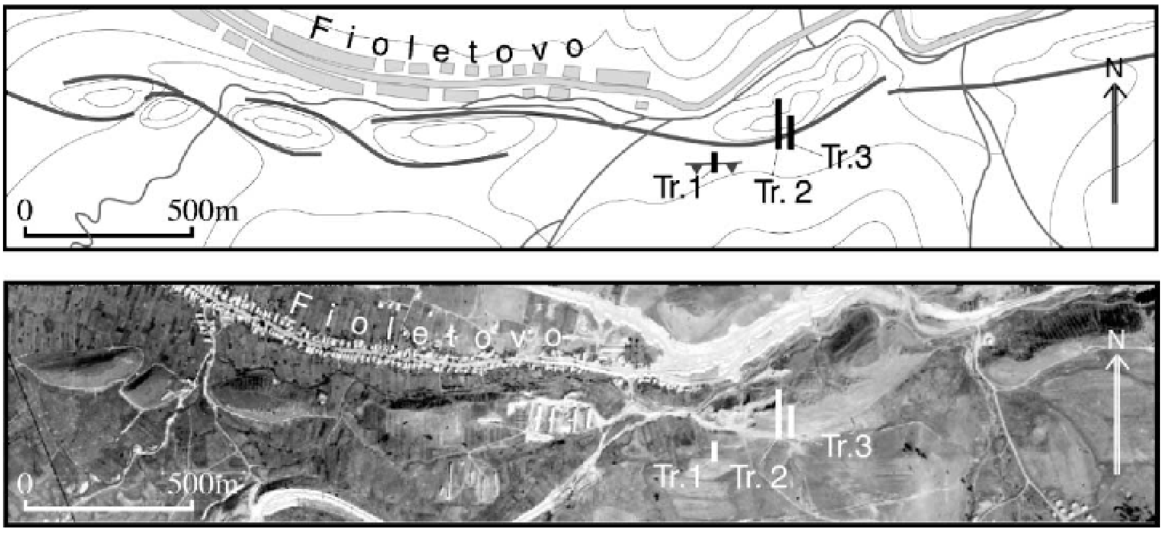

Figure 43. Ridge alignment and trench locations in the Fioletovo site.

Figure 44. Tectonic ridges to the south of Fioletovo village (Fioletovo depression).

Haghartsin Monastery

Haghartsin is a 13th-century monastery located near the town of Dilijan in the Tavush Province of Armenia. It was built between the 10th and 14th centuries (in the 12th under Khachatur of Taron); much of it under the patronage of the Bagratuni Dynasty.

St. Astvatsatsin Church in Haghartsin (1281) is the largest building and the dominant artistic feature. The sixteen-faced dome is decorated with arches, the bases of whose columns are connected by triangular ledges and spheres, with a band around the drum’s bottom. This adds to the optical height of the dome and creates the impression that its drum is weightless. The platband of the southern portal's architrave is framed with rows of trefoils.

The sculptural group of the church’s eastern facade differs in composition from the similar bas-reliefs of Sanahin, Haghpat, and Harich. It shows two men in monks’ attire who point with their hands at a church model and a picture of a dove with half-spread wings placed between them. The umbrella roofing of the model’s dome shows the original look of the dome of Astvatsatsin church.

The figures are shown wearing different dresses — the one standing right is dressed more richly than the one standing left. The faces, with their long whiskers, luxuriant combed beards and large almond shaped eyes, are also executed in different manners. These are probably the founders of the church, the Father Superior and his assistant.

Figure 45. Haghartsin 13th-century monastery.

The gavit of St. Astvatsatsin Church is severely damaged. The ruins show clearly where it stood; however, the walls are almost completely destroyed.

The oldest large structure of the complex, the St. Grigor Church, is accessible through its gavit.

The 12th-century gavit abutting St. Grigor Church is of the most common type of plan. It is a square building, with roofing supported by four internal abutments, and with squat octahedral tents above the central sections, somewhat similar to the Armenian peasant home of the "glkhatun" type. The gavit has ornamented corner sections. Decorated with rosettes, these sections contain sculptures of human figures in monks' attires, carrying crosses, staffs, and birds. The framing of the central window of Haghardzin’s gavit is cross-shaped. Placed right above the portal of the main entrance, it emphasizes the central part of the facade.

One of the half-columns along the right hand wall towards the back has come forward, showing that it is hollow. According to legend, this was swung open and shut in the past and monastery riches were hidden inside at times of war and invasion.

The small St. Stepanos Church dates back to 1244.The Bagratuni sepulchre is where some of the Bagratuni royalty are buried.

Figure 46. Interior of Refectory, built by architect Minas in 1248.

Like the Haghpat's refectory, the refectory of Haghardzin, built by the architect Minas in 1248, is divided by pillars into two square-plan parts roofed with intersecting arches.

The walls are lined with stone benches, and at the western butt wall, next to the door, there is a broad archway for the numerous pilgrims to navigate. Decoration is concentrated only in the central sections of the roofing, near the main lighting apertures. The transition from the rectangle of their base to the octagon of the top is decorated with tre- and quatrefoils. The low abutments determine the size of the upstretched arches. The proportionally diminishing architectural shapes create the impression of airiness and space.

Today this space has large wooden log tables and chairs, and is where receptions take place after marriages or baptisms at the monastery.

Dilijan town

Dilijan is a resort town in Tavush Province of Armenia, situated within the Dilijan National Park. The forested and reclusive town is home to numerous Armenian artists, composers, and filmmakers and features some traditional Armenian architecture. The Sharambeyan street in the center, has been preserved and maintained as an "old town", complete with craftsman's workshops, a gallery and a museum. Hiking, mountain biking, and picnicking are popular recreational activities.

Figure 47. Sharambeyan street in Dilijan with historical buildings

Eocene volcanic and volcano-sedimentary rocks, geological border between two geological terranes

The entire area on the road along valley of Agstev River from Vanadsor to Dilijan and further toward Sevan pass is composed by volcanic, volcano-sedimantary and intrusive rocks of Middle-Late Eocene age. Tunnel on the mountain passes between Dilijan and Sevan crosses Pambak-Sevan-Syunik active fault segment that broadly follows Amassia-Sevan-Akera suture zone that divides two geological terranes (Eurasian margin towards N-NE and south Armenian block microcontinent of Gondwanaland origin towards S-SW).

Post conference field trip, Day 3, 20th September: Start time 09.00 AM

20th September: Tsakhkadsor-Sevan-Nor-Geghi-1 – Yerevan (stay in Yerevan)

1. Tsaghkadsor (09.00 AM)
2. Sevan peninsula, Sevanavank monastery
3. Lunch break
4. Nor Geghi Mid-Paleolithic site (400-200 Ka).
5. Yerevan

Figure 48. Road Map of 20th September excursion.

Lake Sevan.

Lake Sevan is the largest lake in Armenia and in the entire Caucasus Region. It is one of the largest freshwater high-altitude lakes in the world. Altitude of the lake is 1900 m. The geology of the lake and its surroundings represent an interesting combination of Quaternary and Holocene tectonics and volcanism. Lake Sevan, with an area of ~1241 km^2, is the largest lake in the Caucasus region. The lake is located at an elevation of 1900 m and its basin area covers 4891 km^2. The northern part of the lake is named the Lesser Sevan and has the greatest depth (83 m). The southern part, or the Greater Sevan, is twice as large as the Lesser Sevan, but it is only up to 15-17 m deep. The lake has a volcano-tectonic origin.

Figure 49. Lake Sevan with volcanoes of Gegham highland in the background.

Geologically, the northeastern shore of Lake Sevan is characterized by the occurrence of an ophiolitic suture of Middle Jurassic to Early Cretaceous age that corresponds to the structural boundary between the periphery of Eurasia and the South Armenian block (Galoyan et al., 2009; Sosson et al., 2010; Asatryan et al., 2010). The continental collision occurred to the north of the South Armenian block during the Paleocene (Sosson et al., 2010).

Gegham volcanic upland in central Armenia, located to the south from Lake Sevan is a typical example of monogenetic (areal) volcanism in Armenia and is presented morphologically by elongated oval shield. The highest point of the Gegham Upland, among 127 known volcanic centers, is Azhdahak volcano, 3597 m. Period of activity of Gegham volcanic upland is ranging from Late Miocene (Baghdasaryan&Ghukasyan, 1985) up to Holocene (Karakhanyan et al., 2003). Within the upland Late Pliocene-Quaternary volcanic activity is presented by volcanic products erupted from monogenic centers varying in composition form: trachybasalts, baslatic-trachyandesites,- trachyandesites to trachytes trachydacites and trachyrhyolites, (Jrbashyan et al., 2007).

The right-lateral strike-slip Pambak-Sevan-Syunik fault system, which was described in previous section, branches into two segments near the northern shore of the lake. One of the segments, PSSF-2, stretches along the northeastern shore of the lake and south of the thrusts associated with the ophiolitic suture. The second segment, PSSF-3, stretches across the lake floor and reap-pears on its southeastern shore. The western shore of the lake is framed by the N-S-striking system of the normal Gavaraghet faults with horst and graben structures.

The volcanic ridges of Gegham and Vardenis, including many centers of Quaternary areal volcanism, represent the western and southern boundaries of Lake Sevan.

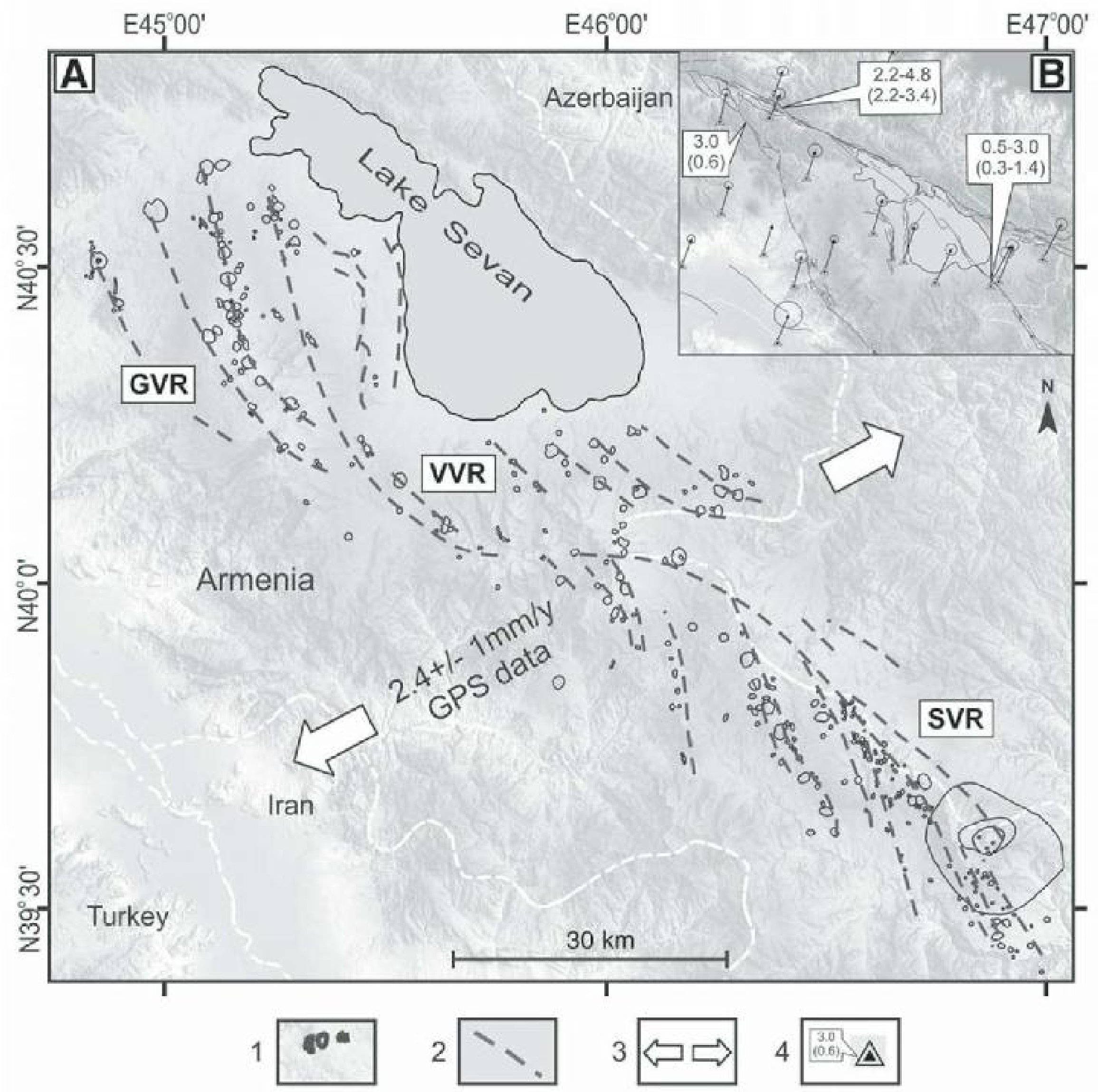

Figure 50. (A) Linear clusters of Quaternary and Holocene volcanoes bearing evidence of extension in an E-W direction. 1—Quaternary volcanoes; 2—linear clusters of volcanoes; 3—extension directions and velocities according to the global positioning system (GPS) data (Davtyan, 2007); 4—horizontal slip rates from long-term geological data and GPS measurements (mm/yr), placed above and below in parentheses, respectively. (B) Slip-rate data from the geological and GPS data. GVR—Ghegam volcanic ridge; VVR—Vardenis volcanic ridge; SVR—Syunik volcanic ridge. (After Karakhanyan et al., 2017).

Sevan Peninsula and Sevanavank monastery

Figure 51. Sevanavank monastery (9th century AD) on Sevan peninsula.

Sevanavank is a 9th century monastery complex located on a peninsula at the northwestern shore of Lake Sevan in the Gegharkunik Province of Armenia, not far from the town of Sevan. Initially the monastery was built at the southern shore of a small island. After the artificial draining of Lake Sevan, which started in mid XX century during Soviet times, the water level fell about 20 metres, and the island transformed into a peninsula.

According to an inscription in one of the churches, the monastery of Sevanavank was founded in 874 by Princess Mariam, the daughter of Ashot I (who became a king a decade later). At the time, Armenia was still struggling to free itself from Arab rule.

The two churches of the complex, Surp Arakelots meaning the "Holy Apostles" and Surp Astvatsatsin meaning the "Holy Mother of God", are both cruciform plan structures with octagonal tambours. Both are quite similar in appearance. Adjacent are the ruins of a gavit whose roof was originally supported by six wooden columns. Some of the remains of the gavit and its columns can be seen in the Yerevan Museum of History.Reconstruction and restoration efforts took place from 1956 to 1957.

Nor Geghi-1 Lower to Middle Paleolithic site

The Nor-Geghi-1 site located in the canyon of Hrazdan River, marks the Lower to Middle Paleolithic transition (~400,000 to 200,000 years BC). The site contains dated sections of lava flows, volcanic ash and paleosols with tools and was studied by international archaeological team, and research is summarized in Adler et al., (2014).

The Lower to Middle Paleolithic transition (~400,000 to 200,000 years ago) is markedby technical, behavioral, and anatomical changes among hominin

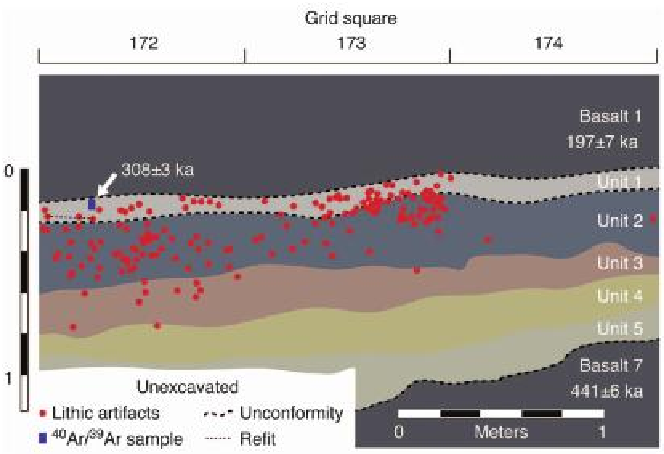

Figure 52. Representative stratigraphic section at Nor Geghi-1 site (after Adler et al., 2013).

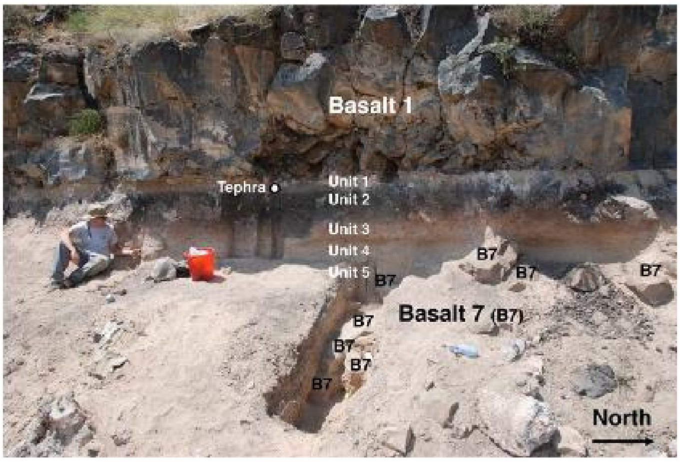

Figure 53. The northern area of excavation illustrating the locations of Basalts 1 and 7, the ^{40}Ar/^{39}Ar-dated tephra sample from Unit 1, and Units 5–1 (after Adler et al., 2013).

populations throughout Africa and Eurasia. The replacement of bifacial stone tools, such as hand axes, by tools made on flakes detached from Levallois cores documents the most important conceptual shift in stone tool production strategies since the advent of bifacial technology more than one million years earlier and has been argued to result from the expansion of archaic Homo sapiens out of Africa. Data from Nor Geghi 1, Armenia, record the earliest synchronic use of bifacial and Levallois technology outside Africa and are consistent with the hypothesis that this transition occurred independently within geographically dispersed, technologically precocious hominin populations with ashared technological ancestry. The archaeology of Nor Geghi-1 is contained within alluvial sediments sandwiched between an upper (Basalt 1) and a lower (Basalt 7) lava flow (figures 52, 53). The^{40}Ar/^{39}Ar technique was used to date Basalt 7 (441 ± 6 ka) and Basalt 1 (197 ± 7ka) thereby bracketing the stratified alluvial sediments between late OIS 12 and the end of OIS 7 (Figure 53). The five stratigraphic units recorded between the basalts (from bottom to top, Units 5 to 1) form a normally bedded sequence of fine-grained sedimentary beds, with aminor proportion of sands and gravels toward the base.

Post-conference field trip, Day 4, 21th September: Start time 09.00 AM

21st September: Yerevan-Aknashen-Metsamor – Erebuni – Yerevan

1. Yerevan
2. Aknashen Neolithic site
3. Lunch break
4. Metsamor archaeological site and Museum
5. Erebuni Urartian fortress and Museum

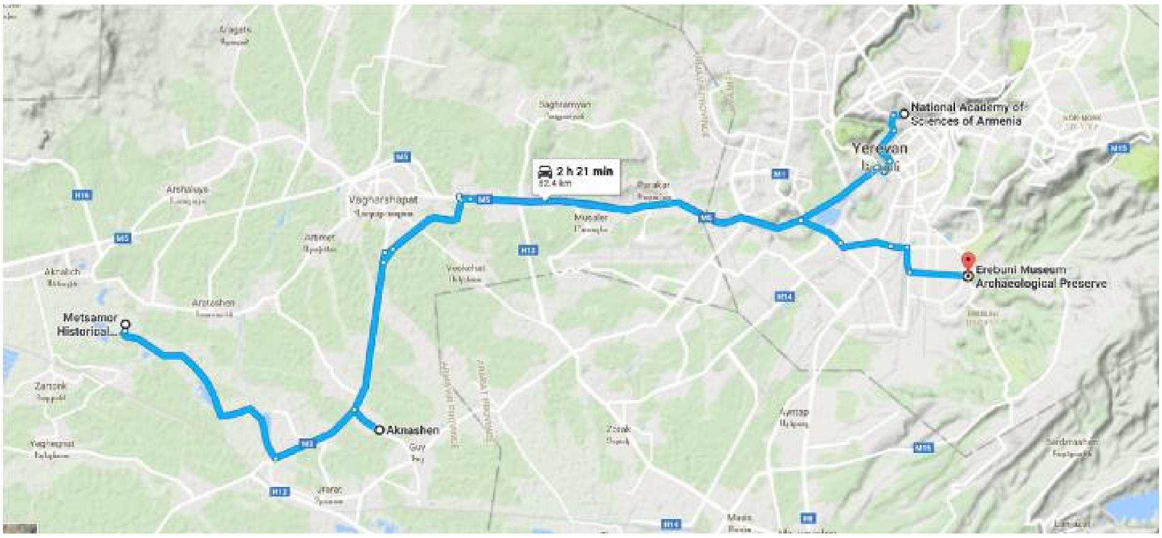

Figure 54. Road Map of 21th September excursion.

Aknashen Neolithic archeological site

Figure 55. View of the Ararat plain and Ararat volcano looking south from the tell of Aknashen.

Aknashen was excavated by the Armenian-French Archaeological Expedition headed, archaeological and geoarcheological data is summarized in Badalyan et al., 2010, Karakhanyan et al. 2017). In the succession of cultures that were present in Armenia, the least known periods are, without any doubt, the Neolithic and the Chalcolithic. In general, the level of study of these periods is far behind in comparison to other cultural phases in the archaeological sequence of Armenia, but also in relation to the same periods in the southern Caucasus. A new stage in the study of the Neolithic and Chalcolithic cultures of Armenia was reached with the excavations of the settlement of Aratashen (1999 and 2004) and Aknashen (2004-present) carried out by the Armenian-French mission. This work has enabled the systematic study of an early farming settlement, a sedentary and stratified village with quite well-defined architectural features; the site, a new archaeological complex for Armenia, has enabled the establishment of a stratigraphic sequence covering several phases of the Neolithic and the Chalcolithic. In this context, recent excavations of Aknashen Neolithic site are very important to fill gaps in our archaeological knowledge related to this period. Aknashen, a Neolithic site in the plain of Ararat, occupies a tell which is about 300 m^2, 100 m in diameter and 3,5 m in height. The cultural layer, more than 4m thick, was subdivided preliminarily into five horizons, the upper one (I) belonging to the Early Chalcolithic and the others (II-V) to the Late Neolithic. A series of ^{14}C dates enables dating the Neolithic horizons to the first half of the 6th millennium.

The site of Aknashen is of major interest for the study of the cultures of the 6th-5thmillennia BC, not only for Armenia, but for the whole of the southern Caucasus, because it is the first site to present clearly a continuous stratigraphic sequence covering the phases of the Late Neolithic and the Early Chalcolithic.

Figure 56. Shaft-hole axes/ adzes lying in situ on a floor (Horizon I).

Figure 57. The trenches on the top of the tell.

Figure 57. Obsidian cores in situ in test trench A (Horizon III).

Indeed, the transition between these two phases was until now very poorly known for the central and eastern part of the southern Caucasus. In the plain of Ararat, at the nearby settlement of Aratashen, the upper layers of the tell, corresponding to this phase of transition, were destroyed. In the basin of the Kura and the steppes of Azerbaijan, the end of the Shulaveri-Shomutepe culture (at the beginning of the 5th millennium BC) (Kavtaradze 1999: 71-72) is marked by the abandonment of almost all the sites and the establishment of new villages belonging to the Sioni culture in more diversified environments, valleys but also high plateaus.

At Aknashen, the lower horizons (Horizons V-IV) with circular architecture built in pise, a rich bone tool and lithic industry, and the very beginnings of a pottery production characterized by grit temper, belong to the 'Aratashen-Shulaveri-Shomutepe' culture. Agriculture (mainly *Triticum aestivum* and *Hordeum vulgare*) and stockbreeding (sheep and goats represent about 90 per cent of the herd) are developed. An evolution is probably taking shape in economic strategy, since Horizon V (even if reached only in a restricted area) is by far the richest from an archaeobotanical point of view, whereas in Horizon IV a strong pastoral character is evidenced by the geomorphological analysis.

Figure 58. Architectural remains in Horizon IV (trenches 1 - 2, 4-5);

In the later horizons of the Neolithic phase (III-II), pottery increases rapidly with a clear predominance of Grit-tempered ware (70 per cent or more), whereas ground stone and bone artefacts decrease in quantity and variety (80 per cent of the bone tools are awls). Herd exploitation is marked by an increase in cattle and evolution towards more milk and wool production (according to the slaughter ages). These elements suggest a gradual modification of the life towards more pastoral and mobile economy.

The Chalcolithic horizon (T) is characterized by a sharp change in the pottery production: Chaff- tempered pottery becomes predominant (68 per cent); this ware often preserves traces of combing and is decorated with perforations beneath the rim, knobs and notches on the rim; some featuresare characteristic of the Sioni culture (Kiguradze and Sagona 2003: 50, fig. 3.6-3.8; 3,13).Therefore, the settlement of Aknashen sheds new light on the transition between the Late Neolithic and the earliest stage of the Chalcolithic. Two factors stand out: a) change is gradual and seamless, with no break between the two phases; b) despite overall cultural continuity, there are important developments in the variety and quantity of objects, especially those associated with subsistence economy, indicating a profound evolution in the way of life.

Figure 59. Architectural remains in the lower part of Horizon V (trench A).

Aknashen is located in Ararat valley, that is about 220 km long and from 25 to 30 km wide. As the valley area accommodates parts of four states - Armenia, Azerbaijan, Iran and Turkey, realization of studies within border areas have been complicated. Certainly, the Ararat Valley represents a tectonic, or a volcano-tectonic depression flanked by large active faults on both sides. These faults are theGarni Fault, Dogoubayazet Fault, Gailatu-Sieh-Cheshmeh Fault and the Maku Fault The northern and southern parts of the depressions are bordered by large Quaternary volcanoes of Aragats ad Ararat. There remains much not known about the structural position of the Ararat Depression. Dewey et al (1986) point out that this is a complex *pull-apart* graben on a wide zone of right-lateral transcurrent motion. In contrast, Yilmaz et al. (1998) consider that the Ararat depression is a left-lateral pull-apart-type basin, developed along a zone of extension between two en echelon segments of the left-lateral strike-slip fault system. Ararat depression as a large structure of *pull-apart basin* type Dewey et al. (1986), bordered by large active faults with the mechanism of right-lateral strike-slip and reverse faulting (Karakhanyan et al., 2004).

The Arax, which is a large river, flows along the central axis of the Ararat Depression. Changes of the orientation and geometry of its channel recorded the activity of tectonic and seismic effects in the Quaternary, inclusive of the Holocene (Karakhanyan et al., 2004).

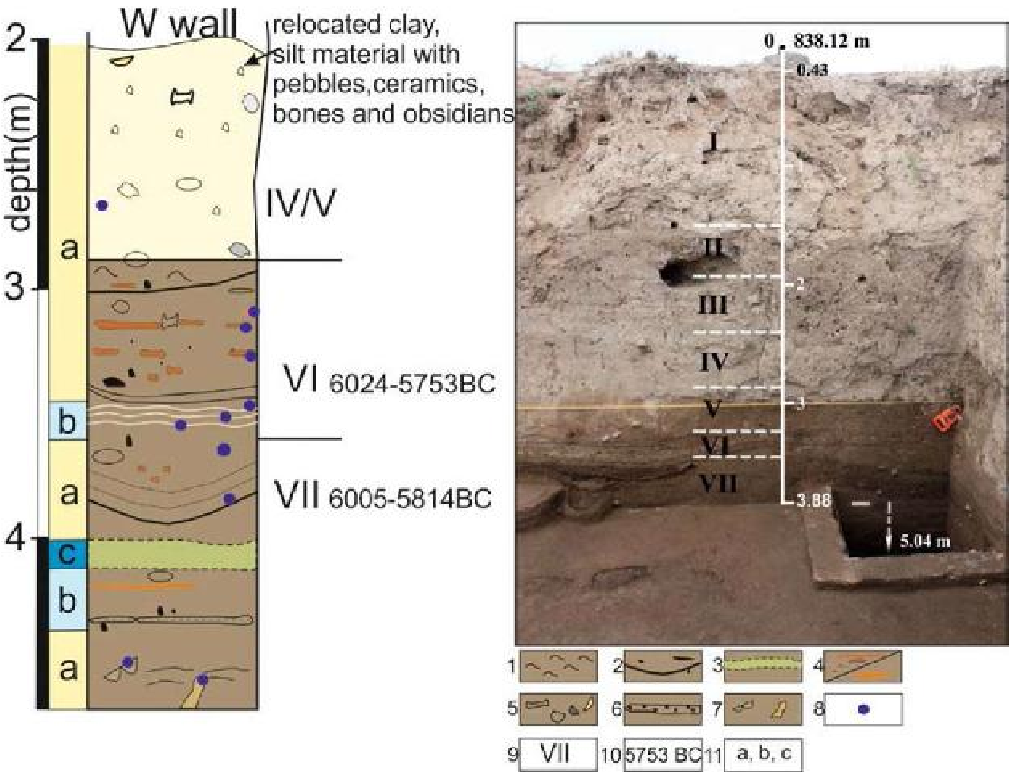

Figure 60. The western wall of the Aknashen archaeological site. 1. Relocated clay material with dark, rounded clay materials; 2. Charcoal particles and lenses; 3. Supposed pale-green unit; 4. a) hematite; b) limonite; 5. Animal bones, pebbles, obsidian and ceramic artifacts; 6. Lens of sand; 7. Archaeological constructions; 8. Sampling points. 9. I-VII are the archaeological horizons; 10. 5753 BC - C^{14}- charcoal ages; 11. a - dryland, b - "varves" wetland; c- water condition.

Karakhanyan et al, (2017 in press) summarize geoarcheological data as follows: based on phytolites studies, in can be concluded, that the site was exposed to wetland and even water conditions.

Phytoliths had larger relative abundance in the unit of "varves", indicating wetland condition. We suppose that the pale-green layer without phytoliths is indicative of water condition.

Therefore, there is a considerable set of evidence to suggest that a lake existed in the Late Neolithic in the Ararat Valley and its shore line varied in the range of elevations of 833 - 834.65 m. The settlements of Aknashen and Massis Blour would have been located near the shores of that lake and their population could go fishing in it. The Aknashen settlement could have been inundated when the water level rose in 6024-5753 BC (C14/AA-68561). Apparently, there was yet another, earlier episode of inundation of the Aknashen settlement (Horizon VII).

There is no clear evidence to estimate how long the lake had been preserved in the Ararat Valley. However, there is an interesting account in Strabo (1964). Strabo mentions that "*as accounted, in the old times the torrent flow of the Armenian Arax from mountains spread over the vast area of the lowland plains and, having no exit, created a sea. And Jason broke a cleft in rock like in the case of the Tempe Valley, through which the river water now flows down to the Caspian Sea. This dried up the Araxena Valley that chanelled the river up to its abrupt flow into the sea.*"

The Araxena Valley corresponds to the Ararat Valley which is closed up in the southeast by the Reshteh-Ye-Dagn uplift, which could have dammed the lake tectonically and turned sharply the Arax River channel toward the Caspian Sea. Potential maximum earthquake magnitudes estimated for several active faults running near the Reshteh-Ye-Dagn massif vary in the range from 7.8 to 7.0. These faults include: the Maku Fault (Mmax=7.4, 37 km far from the dam area), the Siah-Cheshmeh-Khoy North-Tabriz fault (Mmax=7.8, 78 km far from the dam), and the Nakhichevan Fault (Mmax=7.1, 16 km far from the dam). It is suggested that an earthquake on one of these faults could have broken the dam in the Reshteh-Ye-Dagn massif and let the lake of the Ararat Valley to flow into the Caspian Sea.

A mud-brick wall discovered in Trench 6 during the excavations of 2011 at Aknashen had toppled down to the side (Figs. 19). We supposed that the wall shown in Fig. 19 could fell as a result of an earthquake. The age of the fallen wall was estimated in the range of 5850 and 5470 BC.

Therefore, we suggest that the earthquake that occurred in the Ararat valley between 5850 and 5470 BC destroyed walls in the Neolithic settlement of Aknashen. It is possible that the earthquake epicenter was located on the active Yerevan Fault that runs 10 km far from Aknashen.

Metsamor archaeological site and museum

The Metsamor archaeological site is situated in the Ararat Valley, 35 km southwest of Yerevan. It is placed at the edge of Taronik village quite close to the marshy sources of the Metsamor River. The exact historical name of the site is still obscure. The name "Metsamor" (from Old Armenian (Grabar) "big marsh") is rather conventional, just given to the site by the specialists after the Metsamor River. The site occupies the territory of volcano conical hills formed round 150 000 years ago and the adjacent plane. Being located between the Metsamor and Araxes rivers and having excellent land and water routes, this settlement periodically established close economic, cultural, political and ethnical links with numerous historical and cultural Bronze Age–Iron Age centers of both the Armenian Highlands and the Ancient Near East.

In 1963, during the examination of the smelting waste found at the site, a geologist, K. Mkrtchyan, discovered arsenic and tin within the old remains of the bronze slag. In 1965 a Metsamor expedition team was formed to verify this assumption, as well as other noticeable facts concerning this material culture.

In this course, the expedition excavated and examined the remains of the Early Agricultural site of the Early Bronze Age period (the 2nd half of the 4th mill. BC–the 1st half of the 3rd mill. BC) on the upper part of the Mets Blur and the adjacent planes. Those remains comprised the round houses with hewn bases and upper walls built of adobe. Numerous artifacts of the Kura–Araxes culture (obsidian and flint tools, black polished ware, fragments of hearth stands, stone burnishers, mortars, millstones, bone implements, etc.) were unearthed here.

The further excavations at Mets Blur and the adjacent territories proved that this site with a settled population fell into decay in the 2nd half of the 3rd millennium BC, circa 24th–23rd cc. BC, and the territory in question was mainly abandoned for about 400 years. Only from time to time it was temporarily inhabited by the Middle Bronze Age (mainly Trialeti–Vanadzor) pastoral, nomadic tribes and groups.

The excavations carried out at Metsamor site in 1970–1980s indicate that the ethnic bearers of Sevan – Artshakhian and Karmir-Berd cultures again inhabited the settlement from 14th–13th cc BC on, i. e. in the Middle Bronze Age period. According to E. Khanzadyan, in this period the settlement occupied about 20 ha. It was enclosed by high outer walls flanked by the grave field. The main occupations of the natives were farming, cattle breeding, hunting, stone-working. They were skilled builders and produced various types of pottery, bronze tools and weapons, bone implements, ornaments, etc. Painted, as well as black polished pottery with stamped geometrical ornaments comprises the major part of the grave goods The detailed examination of the Middle Bronze Age layer in Metsamor settlement proves that in the period from 19/18th cc up to the 16th c BC the settlement was reconstructed.

The Metsamor settlement reached its full flower in the Late Bronze period (16th/15th cc–13/12 c BC). The citadel was enlarged, the outer walls were fortified, some large sanctuaries, administrative and utility rooms were constructed. This is the period when a huge bronze-smelting workshop was founded here with multifunctional industrial complexes of ore processing, ore dressing and smelting. It is indicated by the discovery of smelting furnaces, copper slag, numerous clay and stone moulds, clay crucibles and other bronze-smelting accessories. In all likelihood, the production of the Metsamor bronze-smelting workshop was in popular demand in both domestic and Ancient Near Eastern markets. The Egyptian scarab stamps and Kassite and Mitannian cylinder seals found in the Late Bronze Age structures and contemporary rich tombs of the site attest to this statement. There are cuneiform and hieroglyphic inscriptions on these objects mentioning the names of Egyptian Pharaohs of the New Kingdom Thutmose III (1479–1425 BC) and Ramesses II (1279 –1213 BC) and Ulam - Burariash, the son of Burna – Burariash (ca. 1346–1324 BC) and Kurigalzu II kings of the Kassite Dynasty of Babylon. The unprecedented expansion of bronze-melting, as well as the hundreds of various tin objects discovered in the burial complexes of the Mid-2nd millennium BC indicate that as there were no local deposits of tin, at this stage Metsamor started participating in Ancient Eastern transit trade of tin and imported some amount of tin for the industrial purposes from the exporting areas.

To all appearance the economic and cultural rise of the site continued also in the Iron Age (12th/11th c–9th/8th c BC). At this stage, the territory of the citadel was again enlarged and fitted out with the second row of outer walls. Outside the citadel city quarters were formed. This attests to the effect that the 2nd mill. BC is characterized by the active urban processes and Metsamor gradually evolved into a city with appropriate administrative, religious, economic and military quarters. In the judgment of some of the explorers, Metsamor might be one of the administrative centres of Etiuni country located in the Ararat Valley and adjacent territories. The social and economic character of the developing city also changed in the 11th – 9th cc BC. Judging by the results of the archaeological studies the unassisted political, economic and cultural rise of Metsamor continued up to the 1st half of the 8th c BC, a period, when by the efforts of Arguishti I the major part of the Armenian Highlands (including the Ararat Valley, the central part of Etiuni) was incorporated into the Van Kingdom (Urartu). In the 1st half of the 8th c BC the Urartians made some reconstructions within the Metsamor settlement. Thus, the outer walls of the citadel were strengthened with new massive buttresses.

Figure 61. General View of Metsamor citadel

Metsamor remained as a town of local importance up to the Achaemenid and Antique periods and, judging by the results of the study of the archaeological findings, survived as a small settlement up to the end of the 18th c.

"Metsamor" historical-archeological museum has been opened in 1968. Currently it is the branch of "Service for the protection of Historical environment and cultural Museum-Reservations" Non–commercial state organization. More than 27.000 monument excavated objects here are collected and exhibited. The objects digging up from the castle and the field of graves dating back from the Early Bronze Age to the Medieval period are exhibited on the first floor. On the second floor samples of crafts and cult of ancient Metsamor are exhibited. The archaeological funds are in the basement: exposition of the objects of Kingdom of Van, as well as the adornments of gold, silver, semiprecious stones, amber, paste etc. In 2011, the excavations were restarted by a new Metsamor archaeological expedition. The team of the Institute of Archaeology of the Warsaw University joined the expedition. Currently the co-leaders of the Armenian–Polish joint archaeological expedition are Prof. A. Piliposyan and Prof. K. Jakubiak. In 2013–2016 the territories of the tombs excavated in 1970–2005 were cleaned out, the inner side of the citadel intended for the further excavations was put to rights, as well as two sondages were made in the northern part of the site – in the citadel and the city quarters.

Figure 62. Excavations in city quarters of Metsamor

Figure 63. Early Bronze Age (Kura-Araxes culture) artefacts

Figure 64. Middle Bronze Age artefacts.

Figure 65. Late Bronze Age (Lchashen-Metsamor culture) pottery

Figure 66. Late Bronze Age stamp and cylinder seals

Figure 67. Late Bronze Age tin objects

Figure 68. Sardonyx frog figurine. A weight of the Babylonian King Ulam-Burariash,son of Burna-Burariash

Figure 69. Late Bronze Age and Iron Age gold objects

Erebuni fortress and Museum

Erebuni fortress is an Urartian fortified city, located in Yerevan. It was one of several fortresses built along the northern Urartian border and was one of the most important political, economic and cultural centers of the vast kingdom. The name Yerevan itself is derived from Erebuni. It was founded by Urartian King Argishti I (786–764 BC) in 782 BC. The fortress was built on top of a hill called Arin Berd (in Armenian "Fortress of Blood"), overlooking the Hrazdan River Valley to serve as a military stronghold to protect the kingdom's northern borders. It has been described as being "designed as a great administrative and religious centre, a fully royal capital.

Early excavations began during the 19th century while more systematic excavations were carried out at Erebuni in 1950, under the joint sponsorship of the Armenian Academy of Sciences' Institute of Archaeology and Ethnography and the Pushkin Museum's Board for the Preservation and Restoration of Architectural Monuments (Russian Federation). The team was led by arcitect Konstantine Hovhannisyan and tamest orientalist Boris Piotrovsky, who served as an on-site adviser.

In the autumn of 1950, an archaeological team discovered an inscription at Arin Berd dedicated to the city's founding, which was carved during Argishti's reign. Two other identical inscriptions have been found at the citadel of Erebuni.

The inscription reads: “By the greatness of the God Khaldi, Argishti, son of Menua, built this mighty stronghold and proclaimed it Erebuni for the glory of Biainili (Urartu) and to instill fear among the king's enemies. Argishti says: The land was a desert, before the great works I accomplished upon it.

Figure 70. The citadel of Erebuni fortress.

Figure 71. Reconstuction of temple of Urartian god Khaldi

By the greatness of Khaldi, Argishti, son of Menua, is a mighty king, king of Biainili, and ruler of Tushpa”. Argishti left a similar inscription at the Urartian capital of Tushpa (current-day Van) as well, stating that he brought 6,600 warriors from Khate and Tsupani to populate his new city. Similar to other Urartian cities of the time, it was built on a triangular plan, on top of a hill and ensconced by 10 - 12-metre high ramparts. Behind them, central and inner walls separated the buildings. The walls were built from a variety of materials, including basalt, tuff, wood and adobe. Argishti constructed a grand palace here and excavations conducted in the area have revealed that other notable buildings included a colonnaded royal assembly hall, a temple dedicated to Khaldi, a citadel, where the garrison resided, living quarters, dormitories and storerooms. The inner walls richly decorated with murals and other wall paintings, displaying religious and secular scenes.

Successive Urartian kings made Erebuni their place of residence during their military campaigns against northern invaders and continued construction work to build up the fortress defenses. Kings Sarduri II and Rusa III also utilized Erebuni as a staging site for new campaigns of conquest directed towards the north.

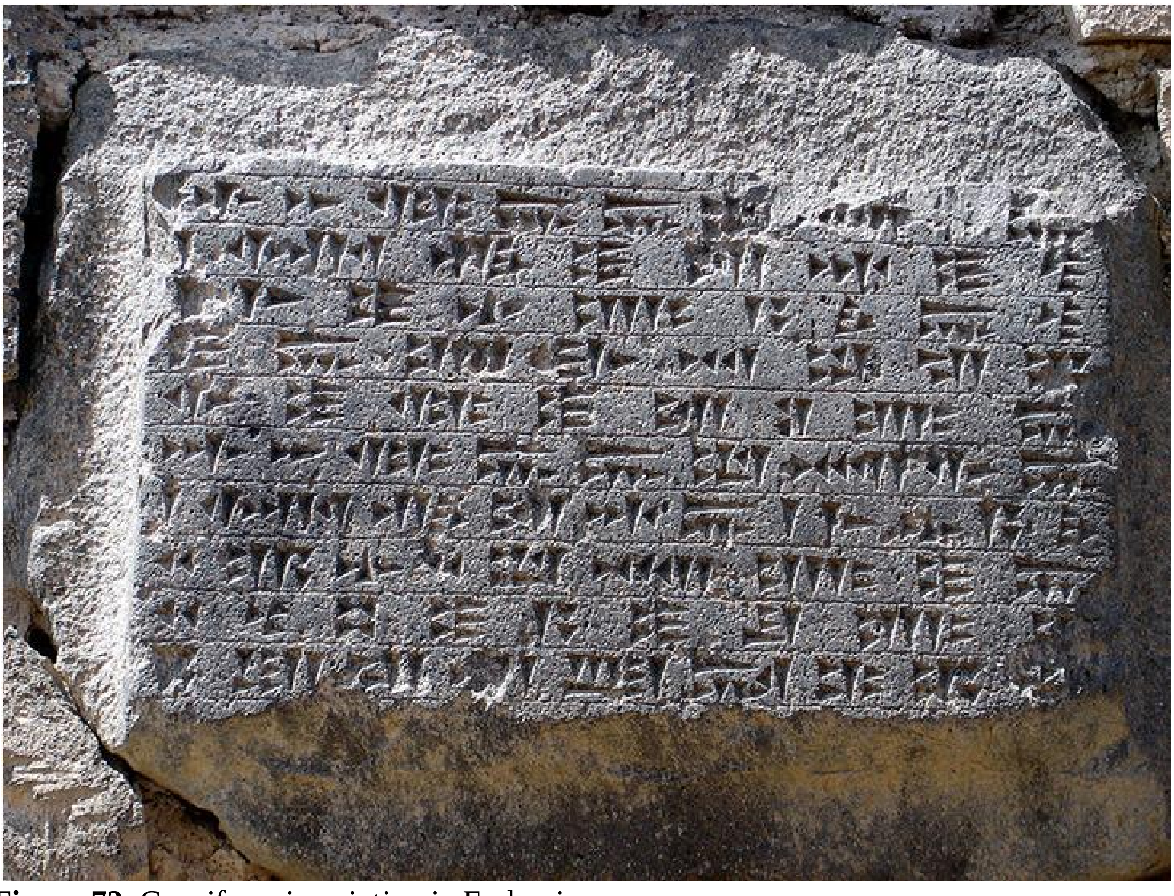

Figure 72. Cuneiform inscription in Erebuni.

In the early VI century BC, the Urartian state, under permanent foreign invasion, collapsed. The strategic position that Erebuni occupied did not diminish, however, becoming an important center of the 13th satrapy of Achaemenian Empire (the satrapy of Armenia).

Despite numerous invasions by successive foreign powers, the city was never truly abandoned and was continually inhabited over the following centuries, eventually branching out to become the city of Yerevan. In 1968 the Erebuni Museum of History was established. Its opening was timed to coincide with the 2750th anniversary of Yerevan. The museum houses items uncovered during the excavations at Arin Berd and Karmir Blur and gives a history of the site.

In 2018 we shall celebrated the 2.800th birthday of ancient Erebuni – Yerevan, the capital of Republic of Armenia.

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ABSTRACTS

SECTION 1. 50 YEARS OF INHIGEO

THE BEGINNINGS OF INHIGEO

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INHIGEO held its first meeting in Yerevan, Armenia on 6-8 June 1967. The first Newsletter was published soon after in same year.

Formal approval for the establishment of INHIGEO had been given three years earlier at the 22nd International Geological Congress held in New Delhi, India in December 1964. The New Delhi Congress succinctly decided "to institute a Commission on the history of geological sciences" with aims "to assist a wide development of researches in the history of geological knowledge (and) the compilation of surveys on the history of geology in separate countries".

The creation of INHIGEO was primarily due to the ideas and efforts of distinguished Russian geologist Vladimir Tikhomirov (1915-1994), who became the first INHIGEO President (1967-1976). The INHIGEO Convener was Professor I.I. Gorsky, Corresponding Member of the USSR Academy of Sciences and head of the USSR National Committee of Geologists. Gorsky formally opened the Yerevan conference and his address was followed by those of Academician V.A. Ambartsumian, President of the Academy of Sciences of the Armenian SSR, Professor W.P. van Leckwijck (Belgium), IUGS Secretary General and Dr A.S. Fedorov, Vice President of the Soviet National Committee of the Historians of Natural Sciences.

The main aim of the Yerevan meeting was the formation of INHIGEO, the preparation of INHIGEO By Laws and recommendations for the managing INHIGEO "Bureau". Overall 150 geologists from 15 countries (Belgium, Czechoslovakia, Denmark, France, Germany – East, Germany – West, Japan, Spain, Netherlands, New Zealand, Poland, Sweden, UK, USA, USSR participated in the meeting which recommended the following Bureau.

President:	V.V. Tikhomirov (USSR)
Secretary General:	K. Maslankiewicz (Poland)
Vice President Europe:	R. Hooykaas (Netherlands)
Vice President North America:	G.W. White (USA)
Vice President Asia:	B.C. Roy (India)
Vice President South America:	VACANT
Other Bureau Members:	J. Kořan (Czechoslovakia), M.J. de Azcoona (Spain), V.A. Eyles (UK), T.G. Vallance (Australia), T. Kobayashi (Japan), G. Regnell (Sweden)

Past President: I.I. Gorsky (USSR)

These appointments were formally approved later by the IUGS Council at its meeting on 23 August 1968.

INHIGEO was initially titled the International Committee on the History of Geological Sciences and until 1968 it had formal links with the organization of International Geological Congress. Also in 1968, INHIGEO became affiliated with the International Union of the History and Philosophy of Science (IUHPS).

After the Yerevan conference recommendation in 1967 and approval of the INHIGEO Bureau in 1968, V.V. Tikhomirov produced a photo record of the first Bureau members. With this record, the acronym INHIGEO is used for the first time as is the INHIGEO logo which remains in use today.

Soon after the first INHIGEO conference in Yerevan, the “New Hampshire Inter-Disciplinary Conference on the History of Geology” was held at Rye Beach, New Hampshire, USA on 7-12 September 1967. This meeting had been in preparation by Cecil Schneer since 1964 and indicates that there was parallel US interest and involvement in the history of geology at the time of INHIGEO’s establishment. The conference volume, published in 1969 contains a contribution by V.V. Tikhomirov.

50 YEARS OF INHIGEO

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The history of the creation and work of the KOGI (Commission for Geological Exploration of the USSR) and INHIGEO (International Commission on the History of Geological Sciences) is associated with the name of V.V.Tikhomirov, the head of KOGI (1958-1992), corresponding member (1963) and full member (1966) International Academy of the History of Science (Paris), president of INHIGEO (1967-1976), corresponding member of the USSR Academy of Sciences (1981). The award in the name of V.V.Tikhomirov, was first awarded to Hugh Torrens at the 34th session of the IGC in Brisbane (Australia) in 2012. For 50 years of its existence, INHIGEO has passed a glorious path: it had 15 member countries since 1967, and 57 - in 2015, comprising 289 members of more than one fifth of all countries in the world.

The 50th anniversary of INHIGEO (which will be celebrated in Yerevan) coincided with the 15th anniversary of Uzbekistan's entry into its structure and the 80th anniversary of the Institute of Geology and Geophysics. These are the milestones of history. The development of the history of geological knowledge in Uzbekistan was carried out under the direct guidance of the KOGI, whose task was to: 1) recreate the history of geological study of the USSR, by issuing summary volumes for 10 periods (1800-1970), summarizing all published and library geological materials for all regions of the USSR; 2) the history of discovery of deposits; 3) the history of geological knowledge, the theoretical analysis of all the accumulated factual material. As a result, 1050 books of the 52-volume edition of the series "Geological Exploration of the USSR" were published. In Uzbekistan, the series was published in the form of 35 volumes on the periods: V (1941-1945), VI (1946-1950), VII (1951-1955), VIII (1956-1960), IX (1961-1965), and X (1966 -1970 remained in the manuscript). Special study on the history of geology were carried out by O.I.Islamov - Doctor of Geological and Mineralogical Sciences, Corresponding Member of INHIGEO, L.A.Vainer - Candidate of Geological and Mineralogical Sciences, L.N. Lordkipanidze - Doctor of Geological and Mineralogical Sciences, full member of INHIGEO, Laureate of the Academician Khabib Abdullaev International Foundation, G.I.Teslenko, V.N.Kushnir, S.V.Gurov, I.I.Sannikova - editor of fund works and specialists of various branches of geological science such as B.A.Beder, G.F.Tetyukhin, V.I.Popov, T.M.Voronich, P.A.Chistyakov, etc. Historical reviews were published in the form of summary chapters on the periods, as well as in “Geology and Mineral Resources” journal (Uzbek geological journal until 1998), editions of the Ministry of Geology of the Republic of Uzbekistan, major monographs and biographies of scientists of the Republic. This year marks the 60th anniversary of the work of L.N.Lordkipanidze in the field of the history of geological knowledge: the study of the main structures of the earth's crust under the guidance of corresponding member of the USSR Academy of Sciences, Kh.M.Abdullaev (1912-1962), then in KOGI and INHIGEO under the leadership of V.V.Tikhomirov (1915-1994) and 15 years as a member of INHIGEO, presenting annual reports throughout Uzbekistan on the most important publications on the history of geology in the materials of the Jubilee International, Republican Conferences, Geological journals and monographs. She is the author, co-author and editor of more than 200 works, including 19 monographs, including the history of geological knowledge from ancient times, the editor of the 7-volume bibliographic index "Geology of Central Asia" (1917-1960), bio-bibliographies of scientists of Uzbekistan, participant of seven international congresses and symposia. She initiated the analysis of creativity of scientists from various fields and schools of the Kh.M.Abdullaev Institute of Geology and Geophysics under the Academy of Sciences of the Republic of Uzbekistan (2007), which was continued by the researchers of the Institute of Geology and Exploration of Oil and Gas Deposits (2009), the G.A.Mavlyanov Institute of Seismology (2016). Jubilee editions, memoirs, memoirs connected with the jubilee events of the institutes, famous scientists have been developed in the Republic. A great event was the visit of Professor Barry Cooper, the Secretary-General of INHIGEO to Uzbekistan in 2014 for participation in the International Conference (Samarkand), viewing of geological museums and works on the history of geology (Tashkent). All this information is reflected in the INHIGEO reports (2002-2015). In recent years B.S.Nurtaev (2014) and O.G.Tsay (2015) joined this direction and currently, they are preparing their publication in Russian and English.

In the half-century anniversary of INHIGEO it is worth to highly appreciate the organizational qualities of her supervisors such as Kenneth L. Taylor, Barry Cooper, and recall the leaders - V.V.Tikhomirov, V.E.Khain, E.E.Milanovsky, D.I.Gordeev, I.V.Batyushkova, E.G.Malkhasyan, congratulate and thank veterans, who together began this difficult path for the faithfulness to this important branch of geological science, and wish to everyone good health and strength to carry out their plans.

EDWARD MALKHASYAN - THE FIRST INHIGEO MEMBER IN ARMENIA

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The name of Edward Malkhasyan, talented scientist is well-known not only in Armenia but also far beyond its borders.

He was born in Tbilisi, in 1926, where his parents had moved to escape Bolshevik repressions. World War 2 caught Edward already in Yerevan where his family had moved to. As all his counterparts, ignited as he was by the sense of patriotism and eager to get conscripted for their country, Edward entered the air-force collage in Astrakhan (Russia). During his training as a pilot, Edward played the French horn in the military orchestra. Unfortunately, the emerging problems related with his eye vision put an end to his career as a pilot. After the war he entered the Department of Geology of Yerevan State University. Still a student he published his first scientific articles. Graduating from university with excellence he chose petrography and volcanology as main directions for his research. The result of his lifelong research was the fundamental study of the Jurassic volcanism in Armenia and it had a crucial impact on the development of Geology as science in Armenia.

The result of his lifelong research was his work "Jurassic Volcanism in the territory of Armenia", which included the fundamental concepts of the Jurassic volcanic complex that had a crucial impact on the geological formation of Armenia.

Edward Malkhasyan is the author of a number of monographies, more than 400 scientific articles. He is also a coauthor of a multivolume publication "Geology of Armenian SSR".

In 1968, together with such distinguished geologists of Armenia as C. Paffenholtz, S. Mkrtchyan and others, Edward Malkhasyan compiled the Geologic Map of Armenian SSR at 1:500,000 scale.

Edward Malkhasyan was a member of the Editorial Board of the Armenian Encyclopedia. For many years he was also the continuing author reviewing chapters devoted to Armenia in the annual publication of "Geological Knowledge of the USSR".

He was also an active social worker. For many years he was a member of the board of the local "Knowledge" Society. To a broad circle of the Armenian public he was known as a lecturer and promoter of the earth sciences and the author of more than 30 popular scientific publications on geology, seismology, ore deposits and other issues.

As an expression of his passion to photography was the publication of a unique album entitled "Geology in Photographs" in 1970. In 2000, with co-authors, he published a guide-book called "Geological Monuments of Armenia".

Edward Malkhasyan was not only a remarkable scientist, but also he was also a professor of Geology at the Pedagogical Institute of Armenia.

History of Geology was another field of special interest for Edward Malkhasyan. Already at the dawn of his scientific endeavor he studied the works of such renowned researchers of geology of Armenian Highlands as Abich, Oswald, Bohne, Spendiarov, Lodochnikov, Artcruni and many others.

Alongside with all the above-mentioned activities he also compiled a unique bibliography of the works devoted to Geology of Armenia, which was published by INHIGEO in 2000.

The managerial talents of Edward Malkhasyan in full measure were utilized with the first INHIGEO symposium that was held in 1967, in Yerevan.

In 1968 for his hard work and great contribution to the History of Geology, Edward Malkhasyan was honored to become the first and the only full member of INHIGEO in Armenia to his last day in 2002.

PERSONALITIES OF THE INHIGEO: FROM MADRID (2010) TO CAPE TOWN (2016)

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Dr. Mike Johnston, the INHIGEO permanent chronicler, regularly and scrupulously publishes reports on INHIGEO symposiums and geological excursions in Newsletter and Annual Record (see Nrs. 42-47). These reports are very factual and provide complete and objective information, but to a lesser extent, they reflect the emotional component of travelers and the relationships of their participants.

We do not aspire to objectivity and completeness of the picture, but we will try to show the emotional side of our meetings and humorous or unusual episodes with participants of these meetings and trips.

The pictures taken during 7 last INHIGEO symposiums will be used for this purpose:

2010 – Madrid, Spain;
2011 – Toyohashi, Japan;
2012 – Brisbane, Australia;
2013 – Manchester, United Kingdom;
2014 – Asilomar, California, United States;
2015 – Beijing, China;
2016 – Cape Town, South Africa.

BETWEEN INSIDERS AND OUTSIDERS: INHIGEO AND THE HISTORY OF GEOLOGY IN ITALY

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The aim of this paper is to present the development of the historical studies on different fields of the geological sciences in Italy in order to evaluate the state of the art of this discipline, to recognize its further interdisciplinary potential and to identify new topics and ways of research, particularly within the activities undertaken by members of INHIGEO in the last 40 years. A critical historical overview will be provided, from the early historiographical attempts in the 19th century until the researches undertaken by geologists and historians during the 20th century to date, within the Earth sciences and the history of science. The different methodological approaches, as well as the results of these studies, will be investigated and compared with other historiographical contexts, mainly in Europe. The role of the history of geology in the modern Italian society, with particular attention to the scientific and academic communities of Earth scientists and historians, will also be analyzed, in order to provide suggestions for more collaborations and interactions between the two cultures. The history of geology must be extremely open and flexible to new models and practices, because its topics are constantly changing and evolving. The future challenge will include the adoption of more specific skills and approaches both in human and natural sciences, as well as the use of technological tools in order to share data and improve the communication of the research work. Historical knowledge in Earth sciences can be also revaluated in applied contexts, in order to understand limits and problems of scientific theories and models.

SECTION 2. DEVELOPMENT OF GEOLOGICALIDEAS AND CONCEPTS

DELUGE, DILUVIALISTS AND DILUVIUM IN EARLY GEOLOGY, FROM LEIBNIZ TO CUVIER AND BEYOND

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This paper will examine the roles played by the Biblical episode of the Flood in the conceptual formation of early Geology, and in particular the meanings of the concept of "Diluvium" from its emergence to its criticism in the Geology of the second half of the 19th century, in France and in England.

The event of the universal Deluge narrated in the Biblical *Genesis* played a central role in geological thought from the 17th century onwards. In England from 1680, in wake of Descartes' "*Principia Philosophiae*" (1644) and Burnet's "*Sacred Theory of the Earth*" (1680), "Diluvialists", reinterpreted the account of the "*Genesis*" in rationalist terms, making the Biblical Deluge the major event of the Earth's history. They were for the most part Protestants, English as Woodward and Whiston, or Swiss like J.J.Scheuchzer, Louis Bourguet, later Elie Bertrand and J.A. de Luc. To the explanation of the "ruiniform" aspect of the Earth, which could only be the result of the Diluvial catastrophe, they added the explanation of the presence of fossils, considered as "relics of the Deluge".

The reference to the Flood is also present in Cuvier's "*Discours sur les Révolutions de la Surface du Globe*" in 1825. In the central part of this text, Cuvier examines the myths which in many civilizations report the episode of a great catastrophe as a prelude to the advent of Humans: according to Cuvier, the biblical account of the flood could well testify to this catastrophic event. The notion of "antediluvial" animals continues to play a central role until late in the 19th century, not only in paleontology, but also in paleoanthropology at the time of its foundation. Still in the 1860's, Boucher de Perthes, the founder of Prehistoric Archaeology in France, advocates for the "Antediluvial Man". We will examine in which way the geological notion of "Diluvium" tends to free itself from the reference to the Biblical text in the course of the 19th Century.

THE FURTHEST END OF THE EARTH: THE ROLE OF GEOLOGICAL RESEARCHIN ANTARCTIC EXPLORATION, 1895-1922

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Following the 1895 Sixth International Geographical Congress declaration that Antarctica was the greatest goal in exploration, an intensive period of Antarctic Exploration (1895 – 1922) was ushered in with multiple expeditions to South Polar Regions. During this Heroic Era, more than a dozen countries expanded geological collecting and began the geological mapping of the continent.

The Belgian Antarctic Expedition (1897-1899) included geologist Arçtowski who managed to collect igneous rocks, study the Antarctic Peninsula, and propose its geology was linked with the Andes. The Anglo-Norwegian British Antarctic Expedition (1898-1900) and the German National Antarctic Expedition (1901-03) followed, with the latter resulting in 20 volumes of extensive scientific results. The Swedish South Polar Expedition (1901-04) contributed with geographical, geological, and paleontological discoveries. However, by the turn of the 20th century there was no scientific consensus on whether Antarctica was an archipelago or a continent.

The new century witnessed expanded Antarctic exploration. Robert Falcon Scott led the British National Antarctic Expedition (1901-03), which established Antarctica firmly as a continent and geologist Ferrar collecting geological specimens from several localities. William Speirs Bruce led the Scottish National Antarctic Expedition (1902-04) that conducted the first oceanographic exploration of the Weddell Sea, while Jean-Baptise Etienne Auguste Charcot led two French expeditions (1903-05, 1908-10) in which geologist Gourdon accurately described the petrology of Graham Land's igneous rocks.

Shackleton's *Nimrod* Expedition (1907-09) came within 156 km of the South Pole. The expedition contributed to the western coast's structural geology, made the first ascent of Mt. Erebus, and collected specimens from the Transantarctic Mountains.

Between 1910 and 1912, the competition to reach the geographic South Pole escalated between Norway and Great Britain. Roald Amundsen led the Norwegian Antarctic Expedition and famously reached the Pole first. His polar party investigated the Queen Maud Range, but their geological descriptions and specimens were sparse. In stark contrast was the British *Terra Nova* Expedition (1910-13) commanded by Scott, whose geological teams made extensive discoveries and returned with numerous specimens. When Scott's Polar Party perished on the return journey, they carried geological specimens, including *Glossopteris*, to the bitter end.

Mawson's Australasian expedition (1911-14) studied basement metamorphic rocks and discovered the first Antarctic meteorite, but is better known for the tragedy that claimed the lives of his sledging companions. Similarly, Shackleton's *Endurance* Expedition (1914-17) is famous for the open boat journey from Elephant Island to South

Georgia Island, although geological investigations were opportunistically conducted by geologist James Mann Wordie.

During the Heroic age, geological exploration was included in expeditions, with some more scientifically oriented than others. In addition to attaining the Geographical South Pole, knowledge of Antarctica's glaciology, petrology, structure, paleontology and stratigraphy had been advanced, with evidence collected that supported Gondwana and Wegener's theory of continental drift. Geologic investigations of this period undoubtedly assisted scientists in placing the seventh continent in its proper global context.

MOUNTAINS, ROMANTICS, GEOLOGY

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Mountains have many associations and meanings: locus of myths; storehouses of water, mineral and plant resources; symbols of national and cultural identity; tests of masculinity through mountaineering; last redoubts of nature unspoiled by human activity; microcosms encompassing environments from tropical to polar, to name but a few. They are also important windows to the vast scale of geohistory and the dynamic geological forces that shape the earth’s crust. Romanticism, especially but not exclusively in its German variants, was crucial for reorienting the way naturalists saw mountains. No longer ruins or remnants of a former more perfect world, mountains became a focal point for understanding nature and for self-understanding. These grand claims will be examined here through the examples of Goethe on the Brocken and Alexander von Humboldt on Chimborazo. This geological romanticism found powerful echoes in the way nineteenth-century artists in the Americas shaped their own national identities through the depiction of mountain landscapes; it also helps to explain the great cultural prestige that geology had won by the late nineteenth century.

THE CHALLENGE OF GEOCHEMICAL EARTHQUAKE PREDICTION - HISTORY OF THE PROBLEM

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The possibility of earthquake prediction was mentioned at the time of birth of the elastic rebound theory by Reid in 1910, and since then repeatedly discussed in the press with controversial arguments. This theory is still the base of understanding the phenomenon.

Study of Tashkent earthquake in 1966 with M=5.1 shows that chemical composition of ground water before an earthquake changes. This discovery busted the study of geochemical prediction around the world. The fortune in the prediction of Haicheng earthquake with M=7.3 at 1975 inspired researchers.However, study has shown the non-triviality of the task. Precursors with different topology appear at different times before earthquakes or did not show up at all.

Numerous failures in prediction allowed some researchers in discussion lead by Geller in 1997 to proclaim non-predictability as a property of earthquakes. After Stein’s recent 2000 laboratory experiments on “earthquake simulation machine“they were declared as “self organized critically” SOC processes that are not predictable.

In Armenia, study for geochemical earthquake prediction began in 1978 by establishing hydro-geochemical observatory stations. Long-term monitoring showed the possibility of early diagnostic of strong earthquake nucleation and evolution process.

Emanations of dissolved helium in underground water were identified as a most universal predictive signal. It appears not as an anomaly but in the form of long time changes in statistical parameters of the observed time series. Retrospective predictions on most strong earthquakes from 1983 to 1994 with magnitude M>5.5 in the region were done.

A predictive signal appears 4.5 months prior to the earthquake and contains enough features to calculate time, intensity and the location of the future earthquake with high accuracy. A new network of observation stations recently created in Armenia allows us to hope that in the near future the tasks of earthquake prediction in the region will be solved.

THE FORMATION, DISSEMINATION AND ITS BACKGROUNDS OF THE THEORY “THE CLIMATIC ARIDITY IN NORTHERN CHINA AND THE SANDS TRENDING SOUTHWARD”（1870-1949）

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Since the modern times, the theory "the Climatic Aridity in northern China and desertification southward" proposed by some western scholars in China aroused widespread concern and strong resonance in the country, and got spread by scholars of various professional backgrounds. Through sorting a large number of the original literature, in the form of chronology, this paper fully demonstrates the formation process and dissemination of the theory, and does as far as possible in-depth analysis on the interaction between the scholars. And then this paper makes a comprehensive explanation for the formation and communication of the theory from aspects of the geographical differences betweenthe Occident and China, the history of learning geographical environment of China by the Occident, national conditions and upsurge of the ethos “science saves the nation” since modern times, the related conclusions by research on historical climate and environmental changes, and makes objective evaluation on the rationality.

BETWEEN THE ORGANIC AND INORGANIC: CONCEPTS OF AN ANIMATED EARTH IN THE DEBATES ON CAVE MINERALS IN EARLY MODERN EUROPE

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In the early years of the 17th century, European scholars became interested in the hidden parts of Earth as antiques collections and windows to the past. In quarries, mines or caves, the history of earth became alive and received spatial presence through the finds of fossils, minerals or rock strata. These previously sacrificed areas, whose inspection was associated with a desecration of an animated earth, were frequented by a growing number of visitors because of economical, knowledge-based and entertaining reasons. Cave minerals and fossils were not only collected by local traders, but also by aristocratic travelers or their agents as medicine, curiosities or decorations for their cabinets. Naturalists like A. Kircher (1602-1680), J. Tournefort (1656-1798), J. Woodward (1665-1728), J. Scheuchzer (1672-1733) and G. Leibniz (1646-1716) widened their private or public collections with the content of caves particularly for the purpose of examination.

The method of comparison necessitated a circulation of cave minerals, bones and their drawings between learned societies and naturalists, who named and described them in catalogs or even visited the places of origin themselves. The exchange of objects resulted in numerous debates on the origins of flowstones and considerations of the way earth had been formed and fossils had come inside the caves. Making no clear difference between organic and inorganic objects, many scholars used anthropomorphic images and metaphors of body and gender to depict flowstones or explained their formation even by vegetative growth. Although there had been a strong belief since ancient times that rocks and minerals were able to increase by growing, the concept of regarding cave minerals as a low form of life revived in the second half of the 18th century. While scholars like N. Brémontier (1738-1809) and E. Patrin (1742-1815) argued that flowstones might represent an intermediate hybrid kind of life between plants and minerals, the debate was also stimulated by the transformation of the term “organism” from its original meaning, in which it designated organized units, to exclusively living beings.

Using the method of historical discourse analysis, the paper examines early modern concepts of an animated earth and their influence on the debates concerning the formation of cave minerals and the origin of fossils. Special attention will be dedicated to the collected objects, the networks of exchange and the different fields of knowledge, which were involved.

BUILDING EARTH SCIENCES THROUGH MINERAL COLLECTIONS.THE MINERALOGY MUSEUM OF THE PARISIAN ÉCOLE DES MINES, FROM THE CURIOSITY CABINET TO THE SCIENCE MUSEUM (1783-1803)

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The period of the French Revolution sees the birth of national museums, which inherit the private cabinets of the émigrés and clergy, seized by the new republican state. These museums, and particularly science museums rapidly become the symbol of the democratization of culture and knowledge implemented by the new Republic, which strengthens its democratic ideals around these new repositories for national heritage.

This time is also that of the chemical revolution of Lavoisier, and a huge discussion agitates the scholarly Parisian milieu. This scientific debate also proves to be tightly connected to the new concerns raised by the industrial Revolution and to the experimentation of new techniques.

This context turns out to be particularly rich in issues concerning scientific and technic collections, especially those of mineralogy and geology, directly linked to the raising exploitation of the subsoil.

We purpose thus to study the way in which Earth Sciences develop themselves in relation to those collections: on one hand within the Ancien Régime's private cabinets, and on the other hand within the new "republican" scientific museums. Indeed, the political transition is accompanied by a change of the way in which collections are formed and displayed.

In order to answer these questions, we choose to base our analysis on the study of the Parisian École des Mines' collections. This scholarly and pedagogical institution, stemming directly from the new challenges posed by the nascent mining industry in France, is founded at the centre of the political and industrial revolution.

From curiosity cabinets to scientific museums, minerals have always aroused both an aesthetical fascination and a scientific interest, upon which the Industrial Revolution superimposes its own specifically economic interests.

The first École Royale des Mines (1783-1794) is strongly marked by the person of its founder, the chemist and mineralogist B.G. Sage (1740-1824), " *curieux du grand siècle* " (Schnapper, 1988). His mineralogy cabinet, an authentic curiosity cabinet, is the first kernel of the School's collection. Partisan of the phlogiston's theory and fervent royalist, his collections are the mirror of his own scientific theories.

Closed in 1794, during the Revolution, the École Royale is replaced by the new Maison des Mines, which then builds its own collections. This institution attempts to find and legitimate its place within the savant Parisian milieu. Once again collections become the chosen instrument in identity building and definition.

A cross-analysis of Sage's collection's catalogues and of those of the Maison Mines will demonstrate how "learned knowledge" is linked to those institutions. This relation is often constructed through objects, and material culture also demands order and classification which are not unequivocal at that time of crucial socio-political changes.

CHANGEOVER OF MINERALOGICAL PARADIGMS DURING THE 350-YEAR PERIOD OF THE EXISTENCE OF MINERALOGY AS A SCIENCE

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For the recent more than 350 years of mineralogy development, it has undergone three scientific paradigm shifts (from the *morphological* – through *chemical* and further into – *crystal-chemical*).

Morphological paradigm of mineralogy has been created by great scientists: Johannes ***Kepler***, Niels ***Steensen***, Mikhailo ***Lomonosov***, Jean-Baptiste ***Romé de Lisle***,René Just ***Haüy***

The creators of the *chemical paradigm* of mineralogy one may treat such scientists as: Abraham ***Werner***, Antoine ***Lavoisier***, Jöns ***Berzelius***, Vasiliy ***Severgin***, Gustav ***Rose***,Eilhard ***Mitscherlich***, Henri ***Le Chatelier***, James Dwight ***Dana***, Norwegian scientist Victor ***Goldschmidt***.

Founding fathers of the *crystal-chemicalparadigm* of mineralogy one may treat such scientists as: Auguste ***Bravais***, Johann ***Hessel***, Axel ***Gadolin***,Evgraf ***Fiodorov***, Arthur ***Schoenflies***, Max von ***Laue***, German scientist Victor ***Goldschmidt***, Linus ***Pauling***, William Henry ***Bragg*** and William Lawrence ***Bragg***, Georgy ***Vulf***, Alexey ***Shubnikov***, Nikolay ***Belov***, Alexander ***Povarennykh***, Vadim ***Urusov***.

The antecedents of the shift of the modern *crystal-chemicalparadigm* of mineralogy have arisen for a period of recent 50–70 years due to the works of the following scientists as: Piotr ***Zemyatchenskiy***, Georgy ***Lemmleyn***, Vladimir ***Vernadskiy***, Alexander ***Fersman***, Paul ***Niggli***, Nikolay ***Sheftal`***, Dmitry ***Grigoryev***, Arkady ***Zhabin***, Nikolay ***Yushkin***, Illarion ***Shafranovsky***, Boris ***Chesnokov***, Otto ***Esterle***, Isiro ***Sunagawa***, Yury ***Dymkov***, Nikolay ***Samotoin***, Ninel` ***Evzikova***, Vladimir ***Popov*** and Valentina ***Popova***, Evgeniy ***Galuskin***.

Mostly due to appearance of local methods of investigations of mineral matter, facts and observations has been accumulating in mineralogy that hardly could be compatible with the now adopted crystal-chemical paradigm such as: findings of biopyroboles, quasicrystals, irregular aperiodic and mixed-layered crystals, establishment of the presence of feedbacks between the minerals and mineral-genetic environment with elements of self-regularity, their ability to accumulate, save and inherit definite genetic information. Now adopted crystal-chemical paradigm is impossible to satisfactorily explain a row of long ago known phenomena as zonality and sectoriality of each mineral body, their ability to structure-morphological and chemical evolution, non-stoichiometry, metamictness, etc. In mineralogy there is no constructional approach to solve the question on the belongingness to the mineral kingdom such “stones” as opals, coal macerals, solid bitumens (kerites), ambers, etc. Thereby, in the modern mineralogy entire complex of unsolved problems has been accumulated and necessity to carry out a revision of the fundamental notions of the science has ripen. It should be choiceless to pass from the now adopted crystal-chemical paradigm to the new one including the previous into it as a component part – ***ontogenical.*** In short that transition one may formulate as follows: from the paradigm with the core conception that “***minerals are essentially crystals or pieces of crystalline space***” to the paradigm where “***minerals are essentially superposition of their surfaces transposition trajectories – elementary layers***”. It will allow to return to the natural and essential notions of mineral “life”: “elementary layer” (more primary than “unit cell”); growth by surface after surface; zonal and sectorial inner structure; evolution (time axis and crystal lattice cannot be adapted by definition) as well as unpainful including into the Mineral Kingdom subkingdoms of mineraloids and caviclusts (nanominerals) on equal terms with crystals.

MIKHAIL LOMONOSOV'S UNUSUAL MID-EIGHTEENTH-CENTURY VIEW ON THE BENEFICENT EFFECT OF EARTHQUAKES ON HUMAN CIVILIZATION

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In 1757, Russian polymath Mikhail Lomonosov (1711-1765) published a lengthy treatise titled (as translated from the original Latin) "Discourse on the production of metals from earthquakes." This little-known work by Lomonosov, only recently translated into English, was published just two years after the devastating 1755 earthquake and tsunami that destroyed much of Lisbon and other cities on the Iberian Peninsula, killing more than 10,000 people. The Lisbon earthquake—the largest European earthquake in historic time—greatly enlivened an ongoing mid-eighteenth-century debate about the causes of catastrophic natural disasters—the so-called "great Enlightenment earthquake controversy."

In the 1750s, there were three, common, mutually irreconcilable positions on the causes of earthquakes: (1) such disasters are directed by divine providence for the purpose of punishing and/or admonishing sinful people, (2) such disasters are due to natural causes, and (3) such disasters are sometimes purely natural and sometime divinely directed. All three of these positions viewed earthquakes as lamentable events. In contrast, Lomonosov, perhaps uniquely, although acknowledging the misfortune of the people impacted by earthquakes, viewed them as having long-term beneficent effects on human civilization by promoting conditions within the Earth in which metallic ores are produced and brought into shallow depths where humans can obtain them. Lomonosov mentions the Lisbon catastrophe only briefly ("the most dreadful fate of the honorable Lisbon"), and he comments on the good fortune of Russia in rarely experiencing such events: "We are not often shaken up by earthquakes, as we can hardly feel them. Rather, we quite enjoy the deep earth's calmness, a happiness felt throughout the country. How blessed Russia is for this!"

The essence of Lomonosov's argument concerning the beneficence of earthquakes is captured in the following passage: "Even though this phenomenon [earthquakes] is both sad and gruesome, if we dwell only briefly on the collapse of entire cities, the destruction of entire countries, and the obliteration of nearly entire populations via the violence of this regrettable occurrence, we are able to appreciate that, in addition to many other benefits, earthquakes produce the most lucrative metals for an endless variety of uses."

Lomonosov does not address the question of divine providence with respect to the generation of specific earthquakes, such as the one that devastated Lisbon in 1755. However, he leaves little doubt that his view of nature and Earth history is one in which a benevolent God created the Earth and its still-active geological processes with long-term human beneficence in mind. Occasional paroxysms, such as the Lisbon earthquake, are unfortunate but unavoidable byproducts of an overall human-friendly Earth. "[A]s is God's will, the repulsive seems to be connected to the agreeable."

Lomonosov's treatise is very process-oriented. He discusses his views on the origin of a wide variety of metals, salt, and volcanoes. He also asserts the then-controversial view "that metals are still being produced [by geologic processes] to this day." In many ways, Lomonosov's 1757 treatise on the role of earthquakes in the generation and accessibility of metallic ores is a precursor to his better known 1763 magnum opus *On the Strata of the Earth*.

BETWEEN CAMERALISM AND NATURAL SCIENCE: WERNERIAN GEOGNOSY AND EXPLORATION OF MINERAL RESOURCES IN HUNGARIAN MINING ADMINISTRATION DURING THE FIRST HALF OF THE19TH CENTURY

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During the first half of nineteenth century a series of proposals and actual attempts was made with the aim to map various deposits of mineral resources in the Kingdom of Hungary. And though most of them did not produce satisfactory results or even failed completely, for the historian of science they provide an excellent material for studying the shaping, use and transfer of knowledge about natural resources in a crucial time, when industrialisation and a new disciplinary structure of natural sciences transformed the mining economy in East-Central Europe.

The systematising of mining knowledge was swiftly followed by bureaucratic and educational institutionalisation of administrative practises in mining. The interest of the early modern state in mining profits led to its direct involvement in mining enterprises, giving among other things preference to utilitarian knowledge and consequently fostering the rise of a new functional group of mining experts during the second half of 18th century.

In (East-)Central Europe it was mainly this institutional context of mining academies (Freiberg, Schemnitz) where systematic knowledge about mineral resources could be acquired and also practised. Especially the Mining Academy in Freiberg became in this field within two decades after it was founded in 1765/66 an international centre of attraction. In non-academic sphere a complementary institutionalisation beyond the cameralist “silver state” of mining administrators was the Mineralogical Society in Jena (1797).

In the first part of my paper I will be dealing with questions of knowledge transfer within this field, prominently between Freiberg and Jena on one side and Hungary (with the central mining academy for Habsburg lands in Schemnitz) on the other side. Based on these questions the plans and attempts for geognostic exploration of mineral resources in Hungary are presented and analysed in the second part of my paper.

GEOLOGY IN THE PUBLIC SPHERE IN MEXICO (1840-1876)

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Historiography on the development of Earth Sciences in Mexico has been devoted to its professional and institutional aspects, including the biographies of its main characters in its evolution and some decisive events, such as the discovery of some mineral or the creation of the first general geological survey. Little has been written about the presence of geological topics in the press, and the interest it might have raised among the general public. This paper will address the spectrum of geological subjects that appeared in Mexican magazines during part of the nineteenth century, in order to characterize them and give an account about its authors and its public.

Scientific contents were a widespread item in Mexican general press during the nineteenth century, as they were in the main European and American capitals, so topics related to geology appeared in almost every magazine. Nevertheless, in Mexico the prime interest of most of them laid in its practical and economical aspects, due to the major role played by mining in the general economy, and theoretical advances where scarcely approached.

Authors of geological articles where mainly lecturers of the National School of Mines, whose aim was to train students in mining exploitation and management. So their essays were concerned with the importance of geological knowledge for those activities, news on technological devices and descriptions of the geological constitution of some mines and geographical regions. They also appealed to the general public, specially mining entrepreneurs and workers, that could improve their knowledge with those studies. At the same time, amateurs wrote about the new theories on Earth's evolution, earthquakes and other phenomena, especially in magazines intended to reach the large public.

THE HISTORY OF SCIENTIFIC FOUNDATIONS OF OIL EXPLORATION (BATTLE OF IDEAS, THEORIES AND CONCEPTS)

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Oil has been known to mankind since time immemorial, but generally accepted date of the birth of industrial oil is considered the receipt of the first oil fountain from the well drilled by “Colonel” Drake in Pennsylvania, 1859.

The “Oil era” began after the creation of an internal combustion engine installed on the first car in 1886. Since then a relatively “young” scientific discipline “Geology of oil” started to form (H. Abich, S. Khant, D. White, D. Mendeleyev, A. Levorsen, I. Gubkin, D. V. Golubyatnikov, K. Kalitsky, M. Abramovich and others).

The whole history of the development of oil science is a battle of ideas, theories and concepts. During the period of the “Stalinist repressions”, many geologists (K. Kalitsky, A. Krems, K. Mashkovich, V. Garoyan and others) found themselves in the camps of the Gulag, only because their scientific beliefs differed from the ideas of pro-government geologists.

One of the main problems of oil geology is the origin of oil. At the beginning of the 20th century academician A. Arkhangelsky mentioned “Knowing where, what from and under which conditions oil is formed, we can look for these conditions in nature and approach the discovery of new oil-bearing regions.”

The dominant theory is a theory of organic origin (Potonye, Trask, A. Arkhangelsky, I. Gubkin and others). In addition to the organic theory, there is an inorganic theory (D. Mendeleev, K. Kalitsky, V. Porfiriev). Both concepts of the origin of oil interpret the conditions for its formation differently. We will soon run out of oil but we have not fully established the conditions for its formation.

Another important scientific problem is theoretical basis of the sites of possible local accumulation of oil - objects of expensive searches. Oil exploration in the bowels without a scientific justification is as difficult as looking for a needle in a haystack. At the dawn of oil industry, the exploration of oil and gas deposits was conducted blindly. At the first stage wells were drilled near the surficial oil outlets. Then methods called “move along the trail”, along the “oil line” appeared. In the USA the “wildcat drilling” method was applied.

In the middle of the XIX century Professor H. Abich from the University of Tartu put forward the “anticlinal theory” at about the same time the “non-anticlinal theory” appeared (Mc-Coy, Keith, A. Levorsen, K. Maslov). In 1911 I. Gubkin has established a new type of deposits, known as channel deposits for the first time in Maykopsky District.

K. Kalitsky (1921) developed an original concept for the occurrence of oil at the place of its formation (“insitu”), industrial oil was found in both schist and crystalline basement. The results of geological survey show that in addition to clever, reasoned, foolproof anticlinal theory, there are other numerous types of industrial oil accumulations that are united by a common term of non-anticilinal deposits. In the USA about 50% of oil and gas deposits are discovered in non-anticlinal traps.

Besides science-based methods of prospecting and exploration published in the works of A. Levorsen, I. Gubkin, M. Abramovich, G. Gabrielyants, E. Yengalychev and others, the methods of “white” and “black” magic, extrasensory, biolocation, etc are used in practice. Such methods, sometimes accidentally, can give unitary positive results, but their application at present stage is an anachronism.

At present stage of development of oil extraction there is a tendency towards the end of the era of “cheap oil”. Due to high degree of exploration of the subsoil, complication of physical and geographical conditions of search objects, there is a sharp increase in the prime cost of a ton of extracted oil. The era of coal ended in due time, not because of the end of coal reserves, but because of the appearance of more economical fuel sources of energy-oil and gas. The same can happen with oil.

GEOMORPHOLOGICAL THEORY IN 10TH CENTURY BASRA (IRAQ): THE EPISTLES OF THE BRETHREN OF PURITY (IKHWAN AL-SAFA), IN GEOGRAPHICAL CONTEXT

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The Brethren of Purity (Ikhwân al-Safâ') was an Ismaili Shiite Islamic sect, which flourished in the beginning of the 10th Century CE in Basra, in what is now Iraq. They were Neoplatonists who compiled an encyclopedic compendium of knowledge, the Epistles (Rasâ'il), dealing with scientific, philosophic and ethical topics. In this paper the geomorphological theory espoused in one of the Epistles is translated in full into English for the first time, and the concepts embodied are discussed in the geographical and historical context of Basra in the 10th Century CE. The Brethren presented a cyclical theory of geomorphology, in which rocks in the mountains and hills, which are exposed to the elements, break down into sedimentary particles, which are carried by rivers to be deposited in layers in lakes and seas. These layers eventually harden to form rocks, which are uplifted to form mountains, and the whole cycle begins again. An analogy was drawn between the geomorphological cycles, and the cycle of emergence and destruction of civilizations. The idea of the sea having been where there is now land, and vice versa (Epistles, Para. I), is something that may have been inspired by the presence of the marine fauna of the Hammar Formation, which outcrops around Basra. The Brethren's explicit analogy of the cyclical nature of geomorphological processes, with the rise and fall of civilizations, may have been informed by both the long history of Mesopotamia, with its ancient cities like Charax and Forat Meisan, near Basra, which had sunk into the sea through subsidence, as well as the destruction of Basra during the Slave Rebellion of the late 9th Century CE, a few decades before the Epistles were written. The influence of the ideas of the Brethren of Purity on later Medieval Islamic scholars, such as Ibn Sina (in his *Kitab al Shifa* or Book of Healing), and Al-Biruni is documented, with new translations.

PROBLEMS OF RESTAURATION OF CULTURAL HERITAGE MONUMENTS FROM THE POINT OF VIEW OF A GEOLOGIST

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The modern principles of restauration have been emerged gradually and based on the deeply ethical approach to the maximal preservation of cultural heritage monuments using the up-to-date science achievements. Such approach assumes a detailed analysis of the monuments` constructional material by specialists. The analyzed monuments and constructions undergo heavy impacts: the castles serve as popular museums; sacred places attend endless streams of the religious. The restauration project should thoroughly record the original composition materials, every stage of previous works, reconstructions, recoveries, in order to make a conclusion: what to do and with which materials so that the monument will remain in its validity, and continue its serving. The investigators of stone blocks are faced with the task not only to determine and record it, but to determine as far as possible the source of its delivery and origin (deposit). The most correct method of restauration – to recoup the losses by the material identical to the original one. Thereby, the modern restauration recommendations are very strict: the ancient stone should be either strengthen or replaced by the geologically identical one. Examples of solving such tasks at the territory of Dzhuma-mosque – the general Muslim sacred place of the Derbent, the most ancient in the Russian Federation, as well as in the medieval Sudak castle (Genoese), the most famous Crimean architectural remarkable sight.

The cases of negative consequences of restaurateur's usage of stone blocks without necessary basement of the data obtained from specialists-geologists (lithologists, mineralogists, petrographers, and paleontologists) are known. Thus, according to the analysis of the white construction stone used in XVII century during construction of the Novo- Jerusalem monastery it was known that it was composed mainly by detritus limestones attributed to the Fusulinida limestones of the lower part of the Moscow stage of the Myachkovsky horizon belonging to the Middle Carboniferous. But during the recreation of the staircase to the gatehouse church and for the paving near the Voskresensky cathedral the stone blocks of geologically different age have been used, and also containing in its composition thin clayey interlayer. Due to it the stairs of the staircase for a period of only one winter-time have been seriously damaged, and so the restaurateur's work has come to nothing.

During the restauration of the Uspensky monastery of the Moscow Kremlin has been wrongly used the Inkerman pearlweed limestone (produced in the Crimea) resembling the original near Moscow white stone. It is characterized by a rather low durability, and faced with Moscow climate it is damaged rapidly due to the weak firmness to the repeated freeze-thaw cycles. Several sentences have been spared to the rather recent discovery of a new macroscopic phenomenon in natural rocks – frustumation (or cryptic structure) – and its possible implication for conservation and preserving from destroying due to weathering factors of architectural monuments, bas-reliefs, sculptures, and small architectural forms as well as for the choosing of the necessary material for its fabrication. It is especially actual for the composite elements of the outer covering of constructions and monuments performed from the precious sorts of marble, quartzite, opal, and alabaster.

THE HIGHLIGHTS AND THE CONTRIBUTION OF INTERNATIONAL RESEARCH GROUP (IRG) "SOUTH CAUCASUS GEOSCIENCES": FRANCE, ARMENIA, AZERBAIJAN, GEORGIA AND UKRAINE

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Initiated in collaboration within the framework of projects funded by the European programs INTAS, Erasmus Mundus and, PICs, LIA programme of the CNRS/INSU, three French laboratories (Géosciences of Montpellier, Géoazur of Nice Sophia Antipolis and Evo-Eco-Paleo of Lille), and Institutes of Academies of Sciences and Universities of Armenia, Azerbaijan, Georgia have founded in 2010 an International Research Group (IRG: GDRI du CNRS/INSU) "South Caucasus Geosciences". Ukraine, presented by Institute of Geophysics of the Academy of Science of Ukraine, became one of the partners of IRG in 2014.

With support of Middle East Basins Evolution (MEBE) and DARIUS programs (consortium of oil companies, Univ. Pierre et Marie Curie Paris VI, and CNRS/INSU) this IRG aimed solving the Earth Sciences questions, mainly in resources and hazard fields, in the Caucasus-Eastern Black SeaDomain (CEBSD) that has a high potential in research since this part of the Alpine belt evolved during the long-lived subduction of the Neotethys ocean due to its closure (see for a review e.g. Sosson et al., 2010, 2015).

The main issues to solve in the eastern Black Sea and Caucasus realm in this geodynamic context are: 1) the time-space evolution of geodynamic processes (subduction, obduction, collisions) responsible for the closure of the northern and southern branches of Neotethys; 2) what is the timing of deformation and evolution of the back-arc basins developed in these tectonic settings; 3) the relation in time and the continuity of structures between the eastern Black Sea, the Greater Caucasus, the Lesser Caucasus and those of the Taurides-Anatolides, Pontides belt and of NW Iran as well.

An integral part of the project, exchange of scientists, apart from the important role of joint research, favored to the development of its International Level, giving the birth to a new generation of scientists able to provide the research in the good tradition of the French (European) geological school (Masters, PhDs, postdocs).

A significant part of these valuable results constitute: two volumes of Special Publications of the Geological Society of London (vol. 340 and 428), also, they have been published in the international and local editions, as well as presented in several PhD Thesises. It is a multidisciplinary study covering topics in structural geology/tectonics, passive and active source seismology and seismic profiling, deep Earth structure (seismic images), geochemistry, palaeontology, petrography, paleomagnetism, geochemistry, geochronology, sedimentology and stratigraphy, reporting results obtained during the DARIUS programme and related projects in the eastern Black Sea and Caucasus realm.

During 2014-2017 our group worked in the region north of the Eastern Black Sea Basin (Crimea), in the Greater Caucasus (Georgia and Azerbaijan), and in the Lesser Caucasus (Armenia, Azerbaijan and Georgia) aiming to precise the evolution of the eastern Black Sea-Caucasus realm primarily during Mesozoic-Cenozoic settings.

During this time the tectonic setting of the area can be characterized as one of general plate convergence as the Neotethys Ocean (or branches of a Neotethys Ocean system) was subducted and eventually closed. The geological record is essentially one of sedimentary basins being formed in an extensional back-arc setting and through to the compressional deformations (inversion) of these basins linked to the Neotethys closure and the consequences of the related deformations. The inversion of basins has roughly occurred in two main phases: 1) from Late Cretaceous to Early Eocene linked broadly to the closure of what is referred to as the northern branch of Neotethys, and 2) from Oligocene to recent, linked broadly to the closure of what is referred to as the southern branch of Neotethys, which corresponds to the eventual suturing of the Arabian with Eurasia.

The main highlights report: 1) onshore geological studies from Georgia, Azerbaijan, Armenia and Iran; 2) onshore geological studies from the Black Sea margins of Crimea and Turkey as well as geophysical data and other subsurface data from the eastern Black Sea and its northern margin.

SYNTHETIC TRENDS IN GEOLOGICAL SCIENCES

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Synthetic trends, the desire to obtain generalized knowledge of the geological objects and the Earth as a whole has always been in the geological sciences and is an important regulative idea of cognitive activity of scientists. Synthetic forms were very diverse: 1) general works (for example, A. Werner, D. Hutton, Charles Lyell, E. Suess, E. Og), associated with the introduction of the geological knowledge of new methods, ideas and principles and showing expansion domain of reality; 2) the emergence of frontier science; 3) attempts to synthesize geological knowledge about major geological problems, such as geological form of motion of matter, energy, geological processes, the role of the biosphere in geological processes, etc.

In the mid-twentieth century, there was a completely new cognitive task associated with the search for logical and methodological ways of synthesis of geological knowledge and geological creation theory and, accordingly, the general earth science (theoretical geology).

On the role of general geological theory it claims to have a number of modern geodynamic concepts. However, they contain a synthesis cannot be considered complete, only because they have a different factual basis. Therefore, these concepts are not alternative, but complementary. In such a situation it is possible by synthesizing a variety of concepts as a basis for synthesizing the hypothesis with the continued use of the principle of reductionism that is logically valid for single-level concepts. It is believed that the synthesizing hypothesis can be the hypothesis of expansion and pulsation of the Earth, hypotheses of fixism and plate tectonics. However, most geologists believe that the general geological theory can be built only on the basis of plate tectonics, which, as noted by V.E. Khain, already assimilated many elements of other tectonic hypotheses - contraction, pulsating and rotary.

SECTION 3. HISTORY OF GEOLOGY IN ARMENIA

THE ROLE OF INSTITUTE OF GEOLOGICAL SCIENCES OF NAS RA IN THE HISTORY OF GEOLOGY IN ARMENIA

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The governmental decree of Armenia of January 28, 1935 established the Armenian branch of the AS of the USSR with three institutes under it, one of them being the Geological Institute. As a renowned geologist, H. Karapetyan was invited to Armenia and appointed geological institute director. The institute started its activity under limited capabilities in terms of staff; of its 22 employees, ten researchers did not have any scientific degree. In 1936, the AS Presidium of the USSR decided to award the degree of doctor of geological and mineralogical sciences and the title of professor to H. Karapetyan, avoiding thesis presentation, considering his scientific and practical achievements.

Up to the 1940s, geological studies in Armenia were led mainly by experts from Moscow and Leningrad (present-day Saint-Petersburg) in view of the lack of local specialists. Department of geology and geography established at the Yerevan State University in 1934, and the mining department opened later at the Yerevan Polytechnic Institute, provided training of local geological staff. Several experts of Armenian origin arrived in Armenia from France, Tbilisi, and Baku and supplemented the staff of the Institute.

Recent concepts on the geology of Armenia are based mainly on the outcome of many years of scientific research led by many generations of institute staff in the field of stratigraphy and paleontology, lithology, tectonics and geodynamics, geological hazards, volcanology, magmatism and metamorphism, problems of ophiolites, isotope geology, ore formation, metallogeny, ore mineralogy and geochemistry, hydrogeology and hydrogeochemistry, engineering geology, and geo-informatics. Diverse types of applied science studies are conducted in the meantime.

The disintegration of the USSR led to significant reduction of the Institute budget and staff, and changed the priorities of the problems studied. In the meantime, within an independent state, the Institute got an opportunity to carry on joint studies with scientists from countries such as France, Switzerland, Germany, UK, USA, Iran, Italy and Taiwan in the framework of international initiatives, including CRDF, SCI, INTAS, PICS, NATO, MEBE, SCOPES, IRG, and other. Currently, the Institute employs a staff of 165, with 12 doctors of science (among them 2 academicians and 1 corresponding member to the NAS of the RA), 39 PHD holders and 35 engineers. Young scientists are trained not only at the Institute, but also at universities of the USA, France, Switzerland and Germany.

Ten divisions now active at the Institute include laboratories of geodynamics and hazardous geological processes, geo-archeology and monitoring, volcanology, regional geology and lithology, petrology and isotope geology, paleontology and stratigraphy, useful minerals, geo-informatics, hydrogeochemistry, and chemistry, as well as the geological museum after Prof. H. Karapetyan, and a scientific library.

Presently, the Institute is the sole scientific research institution of Armenia leading basic and applied scientific studies in different fields of geology both inside the country and beyond the national borders (Egypt, Morocco, Cyprus, Syria, Iran, Russia, Haiti, Georgia).

AN OVERVIEW OF THE HISTORY OF GEOLOGICAL MAPPING IN ARMENIA

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Data on geology in the territory of historical Armenia has been known since ancient times. Written evidence of minerals and their medicinal properties, earthquakes, etc., is found mainly in the priceless works of Theophrastus (315 BC), Strabo (63 BC-23 AD), Pliny the Elder 23-79 AD, Anania Shirakatsi (605-685), Amirdovlata Amasiatsi (1482), Arakela Davrizhetsi (1595-1670), and others.

Graphical representations- the goal of geological mapping- of the geological structure of Armenia, first appeared in the middle of the 19th century. The first geological map of the Caucasus, including the territory of Armenia, appeared in the 6-volume works (1839-1843) of the French naturalist DuBoisde Montpereux. An atlas containing several series of maps, sketches, etc, was attached to this work. Inside the Atlas there are sections dedicated to Armenia. Of particular interest is the voluminous atlas of H. Abich, which was published in 1887 thanks to E. Zius after Abich's death. This atlas contains numerous intriguing sketches, sections, and geological maps, including a geological map of Armenia at a scale of 1: 420000. Approximately 28 different stratigraphic units and rocks are depicted by colored symbols on this map.

F. Osvald's geological map of the Armenian Highlands (1906), was a skillful generalization of geological materials accumulated by the beginning of the 20th century, a result of the work of various researchers. The history of regional geological mapping consists of several stages. 1923-1942: small- to medium-scale (1:420,000; 1:100,000; 1:200,000) planned surveys of the total area of Armenia took place. At the same time, large-scale (1:42,000) surveys by Russian-Soviet geologists (K.Paffengolz, V.Grushevoy, V.Kotlyar, A.Solovkin) focused on individual mining areas (Alaverdi, Kapan). The years 1949-1956 marked the beginning of the compilation of large-scale (1:50000) and medium-scale (1:100000) local geological maps by Armenian geologists (S, Avanesyan, R. Arakelyan, A. Aslanian, P. Yepremyan, S. Mkrtchyan, G. Ter-Mesropyan).

In the second half of the 20th century, a plethora of Armenian geologists (K. Mktchyan, G. Hakobyan, H. Chubaryan, Dzh. Hovhanisyan, V. Amaryan, A. Vehuni, H. Toumanyan, V. Safaryan, and etc.) covered the republic's whole area with detailed scale mapping. The resulting maps were periodically updated in accordance with new requirements and new data on stratigraphy, tectonics, petrography, and etc.

From 1975 to 1991, maps at the scale 1:200,000 were issued. In 2005 E. Kharazyan created a digital map, in Armenian and English, of the Republic of Armenia at a scale of 1:500,000.

HISTORY OF GEOLOGICAL STUDIES OF MESOZOIC OPHIOLITES OF THE LESSER CAUCASUS (ARMENIA, KARABAKH)

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Ophiolites of the Lesser Caucasus (LC), which are an integral part of the tethyan ophiolitic province, have been the object of close attention of specialists for more than a century. The studies of LC Mesozoic ophiolites may conventionally be divided into four main stages: early, middle, late and modern. *Early* or initial phase coincides, mainly with the beginning of scientific geological researches in Armenian Highland. The preliminary information on the geology of the Sevan-Hakari and Vedi ophiolite zones dates back to the beginning and the middle of the 19th century. Later on, G.Abikh (1867, 1882) famous researcher of the Caucasus schematically gave a picture of the geological structure of Armenia and neighboring regions. F.Osvald (1916), one of the major researchers of the pre-revolutionary period, studied the history of the tectonic development of Armenian Highland.

The second or the *middle* stage of investigations coincides with the period starting from 1920s up to the early 1970s. Planned studies on all issues of geology (includ. ophiolites) of Armenian and Azerbaijan SSRs began in 1921 (after the Sovietization of these Republics). Ophiolite studies emphasized the development of mafite-ultramafite (gabbro-peridotite) rocks as in situ intrusions within geosynclines of volcanogenic-sedimentary formations. The age of ultrabasic intrusions was determined as Upper Eocene or pre-Upper Santonian. Rapid development of the geosciences commenced after the Second World War. The study of ophiolites on the territory of Armenia and Karabagh was respectively carried out mainly by specialists of Armenian and Azerbaijan academic Institutions, which focused on their geological-structural and mineralogical-petrographic issues. The beginning of the *late* stage (1970-2000) coincides with the advent of the theory of plate tectonics, when the LC ophiolites became the subject of various studies by numerous specialists from the central scientific research organizations of the former USSR, as well as local researchers. Based on the results of those studies, several issues on the geological position, mineralogy, petrology, geochemistry and geochronology (K-Ar, U-Pb, Sm-Nd) of rocks of the ophiolite series were considered; the genetic association of mantle peridotites with plutonic, volcanic and sedimentary (e.g., radiolarite) rocks in ophiolite series was considered in many of these studies; various hypotheses of the geodynamic conditions for their formation were proposed.

A new or *modern* stage of studies of these ophiolites began in 2003 thanks to the Armenian-French scientific cooperation between the IGS NAS RA and the Universities of Nice-Sophia Antipolis and Lille. As part of it, we conducted structural and paleontological analyses and comprehensive studies of the magmatic and metamorphic products within the Sevan, Vedi, Stepanavan, Amasia and partly in Hakari areas of ophiolite development by using modern analytical capabilities to decipher their geochemical composition and Ar-Ar age dating. As a result, the petrological and possible geodynamic models were developed for the formation of LC ophiolites: beginning with the period of formation of the oceanic crust and ending with the closure of the oceanic basin and their obduction on the continental crust.

THE ROLE OF GEOLOGICAL MUSEUM AFTER HOVHANNES KARAPETYAN OF IGS NAS RA IN THE HISTORY OF GEOLOGY IN ARMENIA

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Geological Museum of Armenia was founded in June, 1937 based on the rich and diverse collections of prominent geologist, Professor Hovhannes Karapetyan and being adjacent to Institute of Geological Sciences of the Armenian branch of the Academy of Sciences of the USSR. Organization of the exhibition was related to the desire of a group of participants of the 17th International Geological Congress in Moscow to get acquainted with the geology of Armenia.

Establishment of the museum was an important event in geological science of the republic; one united center for centralization, processing, display and storage of materials was created.

Later the museum collections were daily supplemented with the samples collected by expeditions of the institute. Geological Museum, being a unit of the academic, scientific system, is called to implement the popularization of scientific works of the institute. Therefore, the collections reflecting thematic works of the institute occupy considerable place beside various samples at present.

The museum has played an important role in the development of geology, personnel training and demonstration of achievements in the field of mineral raw materials research and usage.

The following directors of the museum who followed H. Karapetyan have a great contribution to the creation of the museum and in general, the development of geology: S.Lusyan (1937-1938), A. Hakobyan (1938), S. Tigranyan (1938-1949), N. Sahkyan-Gozalyan (1949-1954), I. Gasparyan (1955-1956), L. Avagyan (1956-1976), M. Mejlumyan (1977-1996) A. Grigoryan (1996-2011), G. Grigoryan (from 2011 up to date).

Due to 80 years of a great and diligent work, at present, the museum has departments of stratigraphy and paleontology, minerology, volcanology, petrography, natural resources and hydrogeology which represent main directions of geological science.

As an informal educational environment, the museum is called to organize its work on a modern level of scientific and technological progress, providing a great factual material on geological structure of the republic, magmatism and resources of bosom of the earth, enabling to have a clear understanding of history of geological development of Armenia.

HISTORICAL OVERVIEW OF DIATOM RECORDS FROM SISIAN PALAEOLAKE (ARMENIA)

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The Pliocene - Quaternary period in Armenia was characterized by active epeirogenic movements and accompanied by volcanic activities. In the course of these geological activities lacustrine basins were created, where exactly diatomaceous sediments were accumulated (Aslanyan 1958, Avagyan 1974).

Previously Armenian diatomites in Syunik region (southern part of Armenia) were investigated by several scientists such as Aleshinskaya & Priumova (1982) and Loginova (1988).

After invention of scanning electron microscope (SEM) many new species and varieties have been described and the taxonomic status of earlier described diatom species has been revised.

For example, Aleshinskaya & Priumova (1982) have found new taxa within *Cyclotella castracanei* group (Eulenstein par Fricke, 1901) in Armenian diatomites. The detailed and ultrastructural investigations of these taxa using SEM permitted Aleshinskaya & Priumova (1982) to distinguish and describe independent species, such as *C. scrobicula*, *C. stellaris*, *C. schambica* and *C. centripetalis*. Lately a new classification of the diatom genus *Cyclotella* (Kützing) Brébisson, was suggested by Loginova (1988), based on ultra-structure investigations of more than 40 species and varieties of the *Cyclotella* (Kütz.) Bréb. species. More recently in Sisian palaeolake basin three different sections (Shamb, Darbas and Tolors) of diatomaceous sediments were investigated. Five different centric species and over 10 benthic diatoms genera were identified. Multivariate analyses of the samples reviled that Shamb, Darbas and Tolors sections were characterized by different diatom communities (Hovakimyan 2015).

Out of five observed centric diatom species four belongs to the *Cyclotella castracanei* Eulenstein (1901) group and one to the genus *Stephanodiscus* (Ehrenberg). Samples from Shamb section were dominated by *Cyclotella cf. centripetalis* with *Stephanodiscus* sp. being subdominant. Samples from Darbas section were characterized by domination of two centric species *Stephanodiscus* sp. and *Cyclotella* cf. *schambica* var. *schambica* with the increscent of the first species towards the bottom of the section. Samples from Tolors section were dominated by *Cyclotella* cf. *schambica* var. *foveata* and *Stephanodiscus* sp.

These results highlight the potential for a more in-depth analysis of diatom assemblages in order to reconstruct past limnological conditions during the Pleistocene in South Armenia.

HISTORY OF GEOLOGICAL KNOWLEDGE IN THE WORKS OF MEDIEVAL ARMENIAN AUTHORS

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The first data about the issues of geology of the territory of Armenia provided in a great ancient historian Strabon's works, refer to the Lydian historian Xanthos' records (5th century BC) about the discovery of petrified bivalve shells on the territory of the Armenian Highland, on the basis of which Xanthos expressed his opinion that once these areas of the land had been covered with sea.

In the works of the Armenian chroniclers, thinkers and historians of the Middle Ages, many of which are carefully preserved in the funds of Research Institute of Ancient Manuscripts after M. Mashtots (Matenadaran) in Yerevan, records are made about various issues of natural science and geology of the territory of Armenia and the Armenian Highland. They include interesting information about minerals, precious and semi-precious stones, mineral colors, ores and their deposits, mineral water and its medicinal properties, etc. Here, in the first place, one should mention the name of a great Armenian scientist and thinker of the 7th century, Anania Shirakatsi. Description of 33 precious stones and their distinctive features is given in his works.

A. Shirakatsi was the first Armenian author who wrote about the structure and causes of earth surface movements (earthquakes). In his opinion, *"earthquakes are caused by strong winds that penetrate deeply into the ground and when they come to the surface they bring death to many cities and destroy buildings"*.

Many Armenian authors of the Middle Ages have made records about earthquakes: Hovhannes Draskhanakertsi, Kirakos Gandzaketsi, Mkhitar Ghosh, Mkhitar Heratsi, Arakel Davrizhetsi, Zakaria Kanakertsi and others. Although most of them did not explain the causes of earthquakes, the precise data about earthquakes, their strength and scales of destruction are of a great importance for paleoseismologists, as well as for the compilation of catalogs of earthquakes. In reference to the latter, the "Catalog of Strong Earthquakes in the Eastern Ecumene" placed in the book of V. G. Trifonov and A. S. Karakhanyan (2004) is of a great value. 300 years later, in the fundamental work "Unnecessary for ignoramuses", Amirdovlat Amasiatsi described some physical characteristics of a large group of minerals, metals and rocks (color, hardness, luster and transparency) using information from ancient manuscripts, most of which have not reached our days. However the work of Arakel Davrizhetsi is of the greatest importance for the development of knowledge about minerals. In 1669 he published the work " Book of the Histories" with articles on precious stones which initiated a serious study of minerals in Armenia.

The territory of Armenia and the Armenian Highland lies in the zone of the continental collision of Arabia and Eurasia within the Caucasian segment of Alpine-Himalayan orogenic belt. Active mountain-forming processes, in particular, earthquakes have occurred here in recent geological past and continue up until now. Therefore, great attention paid to the issues of earthquakes and their catastrophic consequences in the works of the Armenian authors of the Middle Ages is not surprising.

In this regard, a unique facility "Gavazan" which preserved to our days is worth to mention. It was built in the early 10th century on the territory of Tatev Monastery (Armenia, Syunik Region) to fix the movements of the earth's surface, which can probably be considered as a prototype of modern seismographs.

INITIAL STAGES OF MINING AND GEOLOGICAL STUDIES OF THE ANCIENT ARMENIAN REGION OF ARTSAKH

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The historical province of Artsakh in the early Middle Ages was the ninth province of Great Armenia. It currently includes the territory of the Nagorno-Karabakh, or Artsakh Republic and adjacent areas of the Republic of Azerbaijan (B. Ulubabyan, 1994; S. Karapetyan, 2004).

In the early XIX geological investigations were of a purely applied nature and were concentrated mainly in the northern Artsakh, in the ancient Armenian region of Koght. After the death of the famous Russian mineralogist, the head of the Georgian mountain expedition, Count A.A. Musin-Pushkin (1760-1805), an assistant to the head of the Perm plants, mining engineer Matvei I. Loginov was sent to research mining in the Caucasus (Historical essay, 1901). According to M. Loginov, the Zaglik deposit of alumite in the vicinity of the ancient Armenian village of Pib, now the village of Zaglik, South Azerbaijan, was the most valuable among all the deposits of the region. In this regard he notes, "The alumite mine has been developed by Armenians from ancient times and can be developed for many more centuries" (Tikhomirov, 1955, p.493).

The Kedabek copper mine nearby the ancient Armenian village of Getabek (now Kedabek, Azerbaijan), which name in Armenian means «river yard», had also been known since ancient times, but began to be used in 1849 by Greek industrialists, the Mekhov brothers. In 1864 they sold the plant to the Siemens brothers, the famous German manufacturers, who also exploited the Dashkesan copper-cobalt deposits. Another mine of cobalt shine in Dashkesan belonged to the Armenian entrepreneur Ter-Nersesov (S. Karapetyan, 2004; A. Sumbatzadeh, 1964). One of documents of those times claims, "In former times, the inhabitants of the village of Armenian Kedabek worked in the mines, but after a number of misfortunes they decided publicly: not to work in mines as miners ... It is foreign miners from Persia and Turkey who work in Kedabek mines" (A.S. Sumbatzadeh, 1964, p.267).

The most comprehensive studies of the Artsakh province were carried out by Herman von Abich (1806-1886), the "father" of the Caucasus geology and the German academician (Melik-Adamyan, Khachanov, 2009, 2011; Solovkin, 1939). From 1849 to 1866 on the Yerevan - Nakhidjevan - Goris - Berdzor (Lachin) - Shushi - the basin of the river Terter-Evlaakh – Tbilisi route, H. Abikh carried out comprehensive geological surveys on the territory of historical Artsakh. In addition to surveying many active and abandoned mines of non-ferrous metals, much attention was paid to the collection and definition of Jurassic and Cretaceous invertebrates. It is noteworthy that the French paleontologist D. Anthula named *Actaeonella (Volulina) armeniaca* one new species of the Upper Taurus gastropod from H.Abich's rich collection (Anthula, 1899; Rentgarten, 1959). Moreover, from H. Abich's collections from the Upper Cretaceous deposits of the Zaglik alumite deposit, the German paleontologist G. Gurich described a new type of araucaria tree *Araucarioxylon armenicum* and also named it after the Armenian people (Gurich, 1885, Reingarten, 1959).

THE HISTORY OF GEOLOGICAL SURVEY OF THE REPUBLIC OF ARMENIA

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Geological Survey of the Republic of Armenia (formerly Geological Survey of the Armenian SSR, before 1991) was established in 1923with the opening of “Mountainous Department’’and since then has explored many mineral deposits that led to the development of many branches of industry namely mining, chemical, partially food industry, agriculture, etc.The ores of the territory of Armenia were exploited since ancient times and many deposits contain evidences of prehistoric mining of copper, gold, iron and other metals.

The first written evidence regarding the particular mines and mining areas dates back to the late XVIII century.

Geological researching started in Armenia in the early XIX led by foreign specialists. Outstanding German geologist Herman Abich compiled the first 1: 420000 scale geological map of Armenia. Planned and deeper geological research and exploration of mineral deposits began in Armenia after the establishment of the Soviet regime. Numerous mines have been exploited particularly during the Soviet era; many of those were considered the largest in that time. The exploitation of such mines has played a crucial role in the development of industry of the Republic of Armenia. A great deal of work has been carried out in the field of geological exploration of the territory of the Republic. 1:200000 and 1:50000 scale maps have been compiled covering the whole territory of the Republic and reportedly 1:25000 and 1:10000 scale maps of particular areas.

At present, there are many new deposits that are considered promising for further geological exploration.

The Geological Fund of the Republic of Armenia was established on the 27th of November 2002 under the Armenian State Geological Department aimed at recording, coordinating, maintaining and summarizing geological information and still operates.

Currently more than 12500 library materials are being stored at the Geological Fund, including the database of 871 deposits of mineral resources (43 metal, 760 non-metal, 44 ground fresh water and 24 mineral water resources).

Assessing the importance of the information stored in the Geological Fund which corresponds to the international standards and promoting the accountable and transparent management of natural resources, fund materials have been digitalized since the first half of 2016 in compliance with Extractive Industries Transparency Initiative. Based on this, database and website will be created and unified system of geological information will function.

INTERPRETATIONS OF GEOLOGICAL STRUCTURES OF VEDI - YEGHEGNADZOR AREA OVER THE PAST CENTURY

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Most previous investigations related to geo-structural and geo-dynamic particularities of Vedi-Yeghegnadzor locality according to fixistic approaches were conducted. The fundamental geological studies of the beginning 19th century have shown that tectonics of Ararat basin are mainly explained by graben and horst structures, result of stress extension.

According to Shoplo and Vardanian (Shoplo, 1970, Vardanyan, 1978), Lanjanist anticline is a South-West turned brachyanticline, where deformations of Famenian terrigenous deposits are result of magmatic injection occurred after Eocene sedimentation. In cross sections of geological maps of Paffenholz, 1948 (M1:50 000) and Aslanyan et al., 1968 (M1:600 000) Lanjanist fault is presented as reverse.

However, nowadays proponents of plate tectonic are dominance and according to this tenet geological structures of the region are interpreted.

Formation of the main folding structures of central Armenia are result of the ophiolites' obduction, the collision of Eurasian plate and South-Armenian-Khoy Microcontinent (SAKM) in Paleocene-Early Eocene (Sosson et al., 2010), then Arabian and Eurasian (SAKM in the South) plates collision in Upper-Eocene-Lower Oligocene period of times (e.g. Sahakyan et al., 2016). These structures along with smaller tectonic movements and other exogenous (gravitational processes of varying scale, erosion etc.) processes create modern complex structures of the Caucasus. The observations show that the faults mostly have post-Eocene activity in the studied sections, that are continued after the Oligocene-Miocene molassic accumulation as well. The faults stress axes are principally orientated to the North-South; wherever identified the shortening events in this direction, are expressed mainly by thrust and reverse faults kinematics, sometimes with strike-slip component (Avagyan et al., 2015).

ON THE HISTORY OF THE STUDY OF THE ARTIK TUFF DEPOSIT

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The city of Artik near Gyumri (Republic of Armenia**)** is the place where the worldwide famous pink tuff of the largest deposit on the post-Soviet space is mined and processed.

One of the first scientific study of the volcanic rocks of Mount Aragats (Alaghez) was conducted at the suggestion of F.Yu. Levinson-Lessing by Leonid Afanasevich Spendiarov. For this work, the Scientific Council of the Dorpat University awarded L.A. Spendiarov the Master's degree in Mineralogy (1895). An intensive study of the Artik tuff study began in the late 1920's. Tuff advantage over other stone materials has determined the urgency of the work on the detailed geological survey of the object and its exploration. Geological and petrographic study of the volcanic Alagheza Massif was carried out in the 1927–1930 by a detachment of the Transcaucasian expedition of the Academy of Sciences (P.I. Lebedev, B.V. Zalesky, V.P. Petrov, et al.) under the general supervision of academician F.Yu. Levinson-Lessing. The objective of this detachment was the petrographic study of the massif structure. As a result, a monograph was published (1931) and a number of articles with a vast amount of actual material was summarized.

After D.G. Chisliev repeatedly reported on the need of tuff usage in construction industry, in 1928 it was decided to start research work in the Institute of Applied Mineralogy (IPM, now the All-Russian Scientific Research Institute of Mineral Resources). The main task to be solved urgently was to find out the conditions for the occurrence of tuff lava, its relation to other igneous rocks, as well as to study the conditions of tuff wide application in construction. The work was supervised by mining engineer A.A. Ivanchin-Pisarev. According to the standards in 1927, which have remained since the days of Russian Empire, a natural stone could be used in building construction only if its strength was greater than the building possible load by at least 10 times. This resulted in a paradox. Large thin-walled buildings made of tuff existed for many centuries, moreover the strength of tuff is higher than the one of bricks, but it could not be used in construction. As a result of numerous experiments with samples, it was proved that tuff is homogeneous, and standard rectangular defect-free blocks can be cut out of it. The possibility of using the Artik tuff in construction under the same standards as for bricks became obvious and undeniable. A.A. Ivanchin-Pisarev became a pioneer in this research field. The Artik tuff has necessary physical, chemical and mechanical properties for building, but differs from other rocks in an unusual natural color. Pink or lilac shade gives it nobility and turns into a valuable facing material. Tuff is easy to process, so various perfect forms and shapes can be created out of it. Research conducted by the IPM revealed a number of valuable building properties of the Artik tuff. Additionally, the study of sawing methods, mining and processing of tuff lava was carried out. Accomplished results were included in published monographs and were provided to industrial units, as the basis for "Artik tuff" project developed by the IPM. Currently, the Artik tuff is mined on a large scale, and one can find buildings faced with this unique material in many cities of Armenia, but alos in Moscow.

SECTION 4. ANCIENT KNOWLEDGE OF STONE AND METALS

THE IMPACT OF ANCIENT KNOWLEDGE OF STONES AND METALS ON AFRICA

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The layman describes as stone, any abiotic, naturally formed non- metallic mineral matter of which rock is made. Geologists separate them into rocks, minerals and precious stone. Primarily stones and metals have the same origin, which is the molten magma; but are different in composition depending on the geologic process that led to its formation, the geologic environment in which it is formed, and the type of material available. They are composed of naturally occurring elements and about 90 of the elements listed on the periodic table occur naturally. The prehistoric man accessed stones as against metals, with greater ease, utilized them for shelter, stone tools and venerated them. In nature, metals rarely occur in their metallic state but there are occasional finds of meteoric iron, while gold, silver, and copper could occur naturally as 'native' metal, in a relatively pure state. Many regions around the world including Africa underwent various stages of Stone Age development at different times. Native metals were mined and used in a range of applications by the pre- historic man without the need of more complicated separation from the gangue, approximately 5000 years BC. Six metals: gold, silver, copper, tin, lead and iron were the earliest to be utilized. Whatever the controversies Africans were among the earliest to discover stones, metals, and practiced the art of metallurgy. The first known metal to man was copper. Native iron of meteoric origin with high nickel content was the first metallic iron to be used before about 3,000 BC. The Nok culture had existed in Nigeria, Africa, between 1,000BC and 300AD.Copper was used in Africa from about 500 BC, and iron from 200 BC. The oldest Egyptian copper artefacts - beads and small tools - date from between 4,000 through 3,000BC. Microlithic and ceramic industries were developed by Savanna pastoralists from the 4th millennium BC and Kainji Dam excavations in Nigeria revealed evidence of ironworking about the 2nd century BC.Beautiful statues cast in bronze or brass were a special art form in the Benin Empire (1200-1700 AD) in Nigeria. In this write -up, the extent to which Africa participated in the prehistoric development and utilization of stones and metals, but lost out during the Industrial Revolution that followed is discussed. In conclusion, Africa has been and is still rich in raw materials, yet Africa is among the world's poorest. Among the recommendations made is that Africa should overhaul her educational system and make it purpose and technologically oriented while setting an agenda for her type of industrial revolution; since she is still richly endowed with mineral resources.

PREHISTORIC USE OF ORES AND OBSIDIAN IN THE SOUTHERN CAUCASUS

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For many millennia since Palaeolithic times, obsidian was an exceptionally important and valuable raw material in the Old World. The South Caucasus region is one of the key areas for obsidian provenance studies, as it contains many accessible sources of high quality obsidian and abundant archaeological sites which provide evidences of intense use and trade of the obsidian in prehistoric times.

Obsidian sources of the South Caucasus were studied for many years. In this work we present geochemical characteristics of Armenian obsidian sources using 145 new NAA analyses of geological samples from 15 sources of South Caucasus. Aiming to trace sources of obsidian used in prehistoric times, 482 samples of archaeological artefacts were analysed using NAA in the Curt-Engelhorn-Center for Archaeometry in Mannheim, Germany. To utilize a wider database and enhance the consistency of geochemical fingerprinting of sources and reliability of provenancing of the artefacts we used also previously published geochemical data characterizing Armenian and regional obsidian sources.

The analysed archaeological obsidian finds cover almost the whole timeline of regional obsidian usage and trade – from the Middle Paleolithic period (~60 000 years BC) to the beginning of the Iron age (late XII century BC). Geographically, the artefacts studied derive from Armenia and from neighboring areas.

In many cases the analysis of major and trace elements in obsidian allows to distinguish different sources unequivocally, sometimes even between geographically close ones, making it possible to trace back the sources of archaeological artefacts.

Recent archaeological excavations of numerous Neolithic and Chalcolithic sites in Armenia reveal evidence, of prehistoric use of ore minerals such as native copper, malachite azurite, galena, as well as evidences of early smelting of copper. The end of Neolithic period in the southern Caucasus and in the entire greater Near East is marked by common technological practices and structural transformations.

One of the most important of these transformations was the first use of metal, the appearance of which at the end of the Stone Age caused a dramatic change of various areas of human society and resulted in an increase in productivity, the accumulation and redistribution of wealth, the growth of power, the functional differentiation of society, and the development of long distance trade. It is widely accepted that the earliest evidence of copper smelting, frequently defined as the “first technological revolution” (around 5000 BC), is limited to regions of the Near East, southeastern Europe, the Iranian Plateau, and the southern Caucasus. The early appearance of metallurgy in the southern Caucasus and the abundance of copper and polymetallic ores, make this region particularly important for geoarcheological studies. In spite of this, our knowledge about the earliest metallurgy in the region remains limited, and any new discovery such as metal artifacts and metalworking attributes provide an opportunity to study not only the earliest stages of metal production but to understand technology and provenance of metal artifacts and define areas of early mining.

Prehistoric metallurgy studied in last decades in Armenia reveal important stages of early metal use and production such as Late Neolithic use of native copper, the transition to extractive metallurgy in the Eneolithic period, the extensive use of copper, arsenical copper, some other alloys and the early appearance of tin bronzes in the Early Bronze Age and the transition to more advanced metallurgy and alloying in the Middle and Late Bronze Age. Each stage is related to utilization of different types or ores and minerals and contains evidence for long distance trade of metals and ores).

EXTRAORDINARY ARSENIC-RICH ALLOYS USED FOR JEWELLERY IN BRONZE AGE ARMENIA

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In this contribution we discuss chemical compositions, lead isotopes and results of metallographic analysis of some copper based alloys extremely rich in arsenic (15.8-27.6 wt %) and touch upon technological aspects of producing of such an extraordinary alloys. Several pieces of high arsenic alloys from Gegharot and Lori Berd were subjected to chemical, lead isotope and thorough metallographic analysis using optical microscopy and scanning electron microprobe (SEM) in Curt-Engelhorn-Centre for Archaeometry in Mannheim, Germany.

The existence of high arsenic content in decorative objects in Bronze Age metallurgy of Armenia and the Caucasus is a feature repeatedly pointed out by many scholars, but some recently studied metal objects exhibit extremely high As concentration, beyond average arsenic content, exceeding it several times.

A necklace found in Kura-Araxes layers of Gegharot settlement (EBA) consisting of 99 metal (total weight 144.5 g), 88 chalcedony and 217 talc beads (Hayrapetyan, 2005). The EBA-LBA settlement of Gegharot was excavated by an American-Armenian expedition (Smith et al, 2004). Three types of alloys used to make the necklace of Gegharot have been identified by (Meliksetian et al., 2007): These high As beads are characterized by gray, ”silvery” colour, with an insignificant yellowish, “bronze” shade for some of them. We assume that the ancient craftsman used differently colored alloys to give the necklace an extraordinary, “precious” appearance. Lead isotope analysis of EBA objects of the necklace of Gegharot demonstrates considerable variations in lead isotope abundance ratios for different alloys. Therefore, we assume that more than one ore source was used for producing these alloys.

Three exceptional bimetal objects were excavated from the “Royal” tomb 29 of the Lori Berd cemetery by S. Devejian (Lori Berd), and date back to the 12th century BC, following the Bronze Age Armenia periodisation scheme by (Avetissyan, et al., 1996) this age corresponds to end of LBA beginning of IA. One of these objects is a button, another one is a massive ring (or bracelet?) and third object is probably a part of scepter. These object were made of two types of copper alloy: tin bronze with about 9-10 wt % of tin and copper arsenic alloy with arsenic in the range 24.2- 27.6 wt%, these values “beet the record” of highest content of As in artefacts reported for antiquity: earlier 18-21 wt% of As were reported for few small beads from Maikop (Ravich & Ryndina, 1995).

Considering the fact that arsenic is extremely volatile element at temperatures of elting point of copper (1084.5^{0}C), producing of Cu-As alloy seems to be a problematical task. But it is important to note, that temperature of the eutectic point of Cu-As system is much lower - 685 ^{0}C for melt containing 21% of As. With increase of arsenic in the system, up to 27-29% of As, melt temperature rises up to 827 ^{0}C and is still much lower, comparing to melting point of pure copper. But this is nevertheless much higher, than sublimation point of As (615 ^{0}C), so that ancient craftsmen used advanced smelting technology to produce such unusual alloys.

TRANSIT TRADE OF TIN IN ANCIENT NEAR EAST IN BRONZE AGE AND ARMENIAN HIGHLAND

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In the historical and cultural processes of Ancient Near East of III – I millennia BC a special role-plays the discussion and observation of issues concerning to the tin trade. This is particularly important, since tin became most important alloying component to the copper in prehistoric times since Late III Early - II Millennia BC. Absence of any considerable geological tin source in the entire region gave rise to a widely discussed “tin problem” in Antiquity.

In this regard, based on the data of the tin-related geological, ancient, linguistic and mythological studies, several conclusions can be made.

From the boundary of IV-III millennia BC in the bronze casting tin appears as a new component, which originally appears in the copper ore in the form of natural impurity, while at the beginning of II millennium it was intentionally added to the merger. At the same time, both bronze manifestations and ore were used in bronze casting.

Lack of the Middle East natural resources forced the developed early civilizations of the III millennium to look for alternative ways for obtaining the necessary metal from other places.

By this means, the tin transit international trading system, which has a paramount value for the bronze casting of the Middle East as well as of the Armenian Plateau, is being formed at the end of III-II millennia BC and starts it operations at the beginning of II millennium BC.

The western tin was probably brought to the region from the British Isles, the ApenninePeninsula, and perhaps from the European Central Regions (Saxony, Bohemia), while the east tin was delivered to the region from Afghan-Iranian mines. Accordingly, the most promising traders in the western route were Phoenicians, and in the eastern side were the legendary Dilmun merchants.

The Middle East trade of the tin raise the price of the metal with each subsequent sale. This lead to less exploitation of the local mines by the local tribes and state-owned entities. This includes the Armenian Highland, particularly High-Euphrates, Vaspurakan and Persia. According to the written sources, starting from the middle of II millennium BC both the imported and local tin transit trade belonged to the businesspersons of Nairi Land. The latter ones were considered one of the key suppliers of the Northern Syria and Northern Mesopotamia.

At the end of XIII century BC, under the influence of political, economic, social and ecological factors the western route of tin transit trade ceased. Starting from this stage, the eastern side of tin trading has become a priority for both the Armenian Highland and the whole Caucasus. This comes to prove the striking similarities of metal casting and military hardware observed in the last quarter of the II millennium BC and in the middle of the first half of I millennium between the Eastern part of the Armenian Highland and the North-Western regions of the Iranian plateau. Attempts to trace source of tin in Armenian Early and Middle Bronze age were made using application of lead isotopes in bronzes The lead isotope ratios of the some early EBA tin bronze from Talin, Armenia (Meliksetian&Pernicka, 2010) is comparable to most contemporaneous tin bronzes from the Aegean, the Persian Gulf and Dagestan and are different from lead isotope signatures of local ores and copper and arsenic bronzes of that period. However the source of tin bronzes with unusual lead isotope signature is so far unknown.

EMERALD MINES IN THE ARAB–ISLAMIC HERITAGE. UNKNOWN TEXTS IN MODERN WRITING OF MINING HISTORY

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Various sources confirm that the mines were widely available throughout the Islamic world, which reveals the prominent position that was occupied by minerals, as an aspect of Muslim civilization's contribution to the industrial level.

However, many modern studies, which refer to the history of emerald mining, ignore the Arab-Islamic experience in this field. Giuliani, in many individual and collective studies, confirms that the exploitation of emerald mines in Upper Egypt was stopped in 1500 BC, during the Gallo-Romaine period and prior to the Islamic period. This was confirmed by Heuzé (2001) in her survey, about the most works that took care of emerald.

The Arab-Islamic heritage sources included several texts on the emerald mines in Upper Egypt:

- Al-Massoudi mentions that the emerald stone exists in the Upper Egypt near the city of Qeft, and that it is extracted by drilling;

Al-Bayrouni asserts that emeralds exist only in Egypt and its extraction is limited to "Egypt's borders, oases, Mount Al Mokattam and the land of the Bejja";

- Al-Jahidh said that the emerald mines are limited to the Upper Egypt and are not present in any other place in the world;

- Al-Idrissi said that emerald mines, all over the world, are limited to a mountain in the South of Aswan, with the exception of emeralds that exist in one of Rang Island’s mountains (an Indian island located in the tenth part of the first province);

- As well as Al-Zohri reported the existence of the best and the most precious emeralds in the mountains of Aswan.

These texts show very clearly, that Muslim authors were well acquainted with the sources of emeralds, in the world known in their era, where most emeralds were extracted from Egypt, and those areas of India and Iran, which represent now some parts of Afghanistan and Pakistan.

These texts contain several important references concerning the location of the mines, the organization of the work, the emerald’s economic management and its trade, the methods of treatment of the good types, historical data, the description of the rocks that embrace the emeralds and the signs or marks that indicate the gem, or its proximity. These show very clearly the high experience in exploration and extraction of emerald, which was available to the prospectors and metallogenists in Upper Egypt in the Islamic era.

SECTION 5. STUDIES OF HISTORIC AND PREHISTORIC EVIDENCES OF SEISMIC AND VOLCANIC ACTIVITY

1751-1798: THE SUDDEN BEGINNINGS OF VOLCANOLOGY

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Few active volcanoes were known in Antiquity as reflected by the fact that no specific term was designated them. It was thus natural to consider these mountains of fire as accidents scattered at the Earth’s surface, whose heat was produced by subterranean winds or fires. Even the discovery of South America and the volcanic range of the Andes did not change the picture. It was the fortuitous discovery by Jean-Etienne Guettard in 1751 of the volcanic nature of the Chaîne des Puys, near Clermont-Ferrand in Auvergne (Central France), that really signaled the birth of volcanology. Not only did this observation showed that volcanoes were more numerous than those known to be active, but it lead directly to the demonstration by Nicolas Demarest in 1763 of the volcanic origin of basalt. In turn, this discovery further expanded considerably the geological importance of volcanism. A little while later, Lazzaro Spallanzani understood the fundamental role of gas exsolution in volcanic activity from daring observations made in Vulcano during his study of Italian volcanoes made from 1788 to 1790. It was only in 1797, however, that smart observations again made in Auvergne by Déodat de Dolomieu showed that volcanism was not caused by subterranean fires: lava were issued instead from a deep zone within the Earth, which was viscous and pasty, upon which the continents were resting. And experiments during the same period in Scotland by James Hall showed that the critical factor in the formation of volcanic rocks was not the initial temperature of the lava of the time the lava had been kept molten, but its cooling rate: hence, a mineral such as pyroxene [*foreign to fire*)] was not the unmelted residue of the original rock, but rather a mineral quickly precipitating upon cooling. Made within just half a century these five key advances set volcanology on its track. As will be discussed, it is of course no coincidence that they were made during the “heroic age” of geology. If the concept of long geological times was for instance an obvious prerequisite, simple explanations can be given to the apparently surprising fact that only one of the five major steps were made on an active volcano.

ANCIENT BUILDINGS AND SEISMIC CULTURES: THE CASES IN ARMENIA

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The experience of earthquakes has always been a part of the history of the people of Armenia. In Armenia, as in many other countries with high seismicity, the interpretation of the damages and disorders caused by earthquakes could not fail to bring real knowledge of their effects on their buildings. The sources of our observations in Armenia thus covered both the remains exhumed by the archaeologists in the sites of habitats which have now disappeared, and still more the old buildings which have survived, by researching by appropriate readings the events that affected them.

The old communities, by their knowledge of these events, their effects and their consequences, have often been led to develop techniques and constructive seismically resistant elements, that the builders, architects, artisans or simple peasants, were used in monumental buildings, churches, monasteries and fortresses, as in the traditional habitats of the countryside and cities. In the case of Armenia, we find these responses in particular in the techniques of stone cutting and the use of materials, in the search for the balance of masses in buildings, and in constructive devices designed to absorb the energy.

The observations we have made in Armenia are associated with those we have been conducting for more than 30 years in the seismic regions of Europe and the countries of the Mediterranean area in the broad sense. These observations are recorded in a corpus that we have called the Atlas of Seismic Cultures of the Mediterranean countries. This corpus is articulated in three main parts: observations of damage and disorders, repairs and reinforcements, elements of responses to seismic risk in old communities. It highlights both the similarities and differences in the effects of earthquakes in the different regions of the area concerned, as well as the different behaviors of companies subject to seismic risk. Our Atlas of Seismic Cultures thus aims to contribute to the history of earthquakes in an approach that privileges anthropology and human history, by restoring the behaviors of human communities in relation to their environment.

GEOLOGICAL IMPACT ON ST. HOVHANNES KARAPET MONASTERY

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St. Hovhannes Karapet Monastery is located in Ararat Province of the RA, 1 km to northeast of the deserted rural territory of Moshaghbyur (Jnjrlu), on the northern slopes of the Urts Mountains. It was built in 1301 and consists of 3 monumental buildings and numerous structures of a congregation which are located inside and outside the walls. The main building is Spitakavor St. Astvatsatsin Monastery. Currently the monastery is in a dilapidated condition. Along with the geological (geological cross section) and geoengineering studies (three-scale map of a large scale relief which includes landslide and the monument has been compiled) layouts of the most deformed structural components have been drawn. The studies show that the destruction of the monastery complex is not a result of the activation of the Vank (or Moshaghbyur) fault, in the zone of which the monastery is situated. The studies confirm that it happened because of the landslide which was activated as a result of the historical destructive earthquake in 1840.

PALAEOSEISMOLOGICAL EVIDENCES OF STRONG EARTHQUAKE REPETITION IN SHIRAK BASIN

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The knowledge of past strong earthquake history is fundamental for areal seismic hazard understanding. One of the principal hazard elements is the recurrence rate of strong earthquakes. The thick lacustrine formation accumulated in the Shirak Basin since Upper Pliocene. The upper Ani (1.25-0.75) and Arapi (0.7±0.05) sedimentary units composed of lacustrine clays, silts, diatomite downward and alluvial sands, gravels and pebbles upward. The mineralogically similar to overcoming Leninakan tuff formation is below lava flows, which reopens the question of the more recent flows existence.

The lithological succession of lacustrine and alluvial sediments with water saturation in the high seismic active area give opportunity to investigate the past earthquake history. Numerous seismites are discovered: eight levels in the Ani and four-five levels in Arapi unit. The analyses of the seismites' levels situation suggest at least eight earthquakes of Mw>5 occurred during maximum of 0,5Ma.

THE DOG'S GROTTO: GEOLOGICAL INQUIRIES FOR A MYSTERIOUS GAS (18^{th}-19^{th} CENTURIES)

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Near Naples, in the geological region called *CampiFlegrei* (Italy), there is a cave known as the Dog's grotto where a mysterious vapor hovered low to the ground can kill, so often ancient writers believed that was a gate to hell.

The Phlegraean Fields (which means burning fields) is a large volcanic area where for many centuries scholars from all over the world (mainly Europe, of course) came attracted by the variegated phenomena, of boiling lakes and killing caves. In particular, the Dog's Grotto is omnipresent in works describing harmful emissions, but they do not correspond to an equally frequent, and above all very accurate descriptions of scientific experiences. This fact is less surprising when you consider the special characteristics of the (geographical, historical, and anthropic) context surrounding the grotto. As regards the study of gases, every chemical study carried out in the Dog's Grotto was complicated by the difficulties tied to field work itself, especially when the field was actually a system of volcanoes which was not completely extinct, older calderas, volcano lakes, but also the fact the instruments were too heavy or fragile, or simply because the use of a particular instrument had not been foreseen, and going back to get it was not feasible.

Despite its name, the death of "the dog" was not the rule, it means that many times different kind of scientific experiments were performed by local scholars for foreign visitors, so the grotto was quickly and widely considered a site for chemical studies about gases and the whole geological area became an open-air laboratory. Above all scholars could consider actual phenomena of the grotto as effects of an ancient volcanic activity giving to it the same heuristic importance of a recent volcanic eruption.

The paper goal is to describe by means of travel journals, chemical writings, books about volcanic stuff, reports about open-air experiments or pictures the history of the *Grotta del cane* as a site of scientific enquiry about gases from the late XVII century to the early XIX. Then, going through the scholars and personalities interested in this site and the different historical periods involved, I will try to highlight the effects of all these different interests on the social, cultural and political value of this volcanic area of the Kingdom of Naples.

PALEOSEISMOLOGICAL STUDIES OF THE EASTERN PART OF KARKAR-TSGHUK PULL-APART OF PAMBAK-SEVAN-SYUNIK ACTIVE FAULT

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Palaeoseismological and morphotectonic studies are crucial in the evaluation of seismic risk which were carried out in the area of 3-3,5 km located in the north of Lake Sev. Two palaeoseismological trenches were excavated in the investigated areas to identify recent seismic activities.

The studies carried out in the first trench showed that topsoil covers volcanic formations and graben structure that cuts the lower clayey layer.

Stratigraphic analysis in the second trench revealed at least one seismic activity. Identified dip-slip fault is covered with modern soil.

Nine (C^{14}) samples were chosen for dating, five of which had been taken from the first trench and the remaining four had been taken from the second one.

Cross-general analysis proves young Holocene tectonic activation on the eastern part of Karkar-Tsghuk pull-apart.

SECTION 6. GENERAL CONTRIBUTIONS AND BIOGRAPHIES OF FAMOUS GEOLOGISTS

RESEARCH IN THE CRIMEA, THE CAUCASUS AND ARMENIA BY ARMENIAN GEOLOGIST N.I.KARAKASH

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One of the leading geologists in the Geological Committee of Russia, professor Nikolay Karakash (Nikoghayos Hovhannes Karakashyan) was born on June 25th, 1862, in the Crimea in the family of an eminent Armenian landlord Hovhannes Karakash and Varvara Patkanyan who was a sister of Rafael Patkanyan, the famous Armenian poet and public figure. The scientist's ancestors from Ani, the ancient capital city of Armenia, were stonecutters, hence their surname ("kar kash" means "stonecutter" in Armenian). After migrating to different places, they settled down in the Crimea and became landlords (Arkadyev et al, 2010; Asratyan, 2015; Melik-Adamyan, 2016).

For 30 years of his scientific, experimental and teaching career, the major scientist wrote about 60 works in Russian, German and French, including 2 fundamental monographies in 1897 and 1907, that covered paleontology and stratigraphy of Jurassic and Cretaceous deposits of the Crimea and the Caucasus, (Starodubtsev, 2012; Mandalyan, 1999).

One of his research was devoted to his friends: the outstanding German paleontologist, president of Bavarian Academy of Sciences Carl de Zitter (1839-1904) and the world-famous stratigrapher and paleontologist, specialist on the Cretaceous system, president of World Congress in Zurich (1894), professor of Lausanne University, Eugène Renevier (1831-1906) with whom he made friends when he worked with some collections of fossil Cretaceous invertebrates in Lausanne University and in the Paleontological Museum in Munich, as well as in museums of Paris, Zurich, Geneva, Lyon, Berlin and Vienna.

In "The Early Cretaceous Deposits of the Caucasus and their Fauna" N.Karakash collected and described 374 species of Early Cretaceous invertebrates among which he identified 85 new species, 45 ammonites, and 14 Gastropods; for the first time he identified and validated by the fauna all the 5 stages of the Early Cretaceous period beginning from the Beriassian up to the Alpian stage. In addition, in the vicinity of the town of Gurzuf, the Crimea, the scientist was the first to paleontologically verify the existence of Late Oxford and Early Kimmeredgian deposits (Lusitaian stage), and in the mountainous Crimea he was the first to identify the Kimmeredgian stage on the grounds of the fauna (Kolganov, Komarov, 2016).

In the 1880s N.Karakash as the geological consultant took an active part in the building of the Transcaucasian (Tiflis – Kars) Railroad (Mandalyan, 1999). It is noteworthy that during the construction works near the village of Shirakamut, Northern Armenia, for the first time in the Caucasian region the scientist found some fossil remains of an Upper Pleistocene wooly mammoth *Mammuthus primigenius* (Karakash, 1898; Mandalyan, 1999).

Leading paleontologists V. Uhling, K. Simonesku, S. Breskovski, V. Rentgarten, V. Drushits, V.Shimanski and others named more than 20 species and 1 genus of Upper Jurassic invertebrates in honor of N. Karakash. Currently the ammonite biozone Karakaschiceras inostranzewi for Western-Mediterranian province includes Upper Triens of Lower Valanginian (Reboulet et al, 2014; Tieuloy, 1977).

In 1916 the scientist was buried in Smolenskoe Armenian cemetery, St.Petersburg.

THE HERITAGE OF THE AUTHOR OF THE FIRST RUSSIAN MONOGRAPH ON THE HISTORY OF GEOLOGY GRIGORY E. SHCHUROVSKY IN THE COLLECTIONS OF VERNADSKY STATE GEOLOGICAL MUSEUM

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In 1835-1880, Grigory Efimovich Shchurovsky (1803-1884) was Professor of Geology and Mineralogy at Imperial Moscow University. At the same time, he was the head of the University’s Mineralogical and Geological Cabinets (museums).

His contribution to the study of geology and the history of geology in Russia was noted by Dmitry Anuchin (1885), Anatoly Bogdanov (1885), Alexey Pavlov (1885), Vera Varsanofeva (1941, 1947), Demian Gordeyev (1954), Semen Mikulinsky (1958) and Boris Raikov (1965). Shchurovsky was recognized as one of the founders of the Moscow school of geologists in articles by Eugeny Milanovsky (1976, 2004), Boris Sokolov and & Anatoly Ryabukhin (1998). Mikhail Tolstopiatow (1885) and Zoya Bessudnova (2006, 2013) have discussed the work of Shchurovsky in his role as the head of the University’s Mineralogical Cabinet (Museum).

In 1838, he travelled to the Ural Mountains for four months. Based on this journey, Shchurovsky wrote the book: *The Ural Range in its physiographic, geological and mineralogical aspects* (1841). He described the history of geological studies of the Ural Mountains, created a holistic representation of their structure and described the mineral resources of the Urals.

In 1844, Shchurovsky madean eight-month journey to Altai. In 1846, his work *Geological tour across Altai, with historical and statistical data on Kolyvan-Voskresensky factories* was published.

In these trips, he collected specimens of rocks and minerals, which complemented the domestic collection of the Moscow University Mineralogical Cabinet (Museum). He studied and systematized Museum’s collections. Shchurovsky’s work on ordering of the collections of the Museum proceeded over 10 years and came to an end with the compilation and publication in 1858 of the *Catalogue of the Big and Small mineralogical Cabinets at the Imperial Moscow University*.

Shchurovsky wasone of the firstpopularizers ofscience and one of the first historians ofgeology inRussia. In the field of the history of geology, Shchurovsky wrote biographic sketches about known scientists such as Michael Lomonosov (1711-1765), Grigory Fischer von Waldheim (1771-1853), Leopold von Buch (1774-1853), Alexander von Humboldt (1769-1859) and a book *On the historical development of Natural History in Russia* (1869). He thoroughlystudied the history ofgeology of the Caucasus andin 1862 published aseries of essaysabout it.

Shchurovsky was the author of the first Russian monograph on the history of geology *History of Geology of the Moscow Basin*. This two-volume monograph was published in 1866-1867. The monograph is often quoted in the works of present-day investigators of the geology of Russia.

One of the showcases at the exhibition *Historical collections* in Vernadsky State GeologicalMuseum is devoted to the activity of Shchurovsky in the Mineralogical and Geological Cabinets (Museums). *The Catalogue* (1858), compiled by Shchurovsky, remains to this day one of the essential guides for employees working with old collections in the Department of Collections of our Museum.

TRANSCAUCASIAN ACADEMIC EXPEDITION (1927-1930) LED BY F. LOEWINSON-LESSING

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In 1926, the Transcaucasian Commission established in the Academy of Sciences of the USSR under the direction of academician Franz Yu. Loewinson-Lessing (1861-1939). He has studied Caucasus since 1891, published dozen of papers about this region. Loewinson-Lessing also worked in the International Geological Congresses (7th-17th sessions) on the commissions of igneous rocks classification and nomenclature, and had been recognized as the founder of the Russian petrographic school.

The Commission organized the Transcaucasian Expedition to survey the basin of Lake Sevan (former Gokcha Lake) in 1927-1930. The main goal was to study area around the lake and the nearest volcano Aragats (former Alagez) for the needs of irrigation and hydroelectricity. Scientists, in cooperation with the Sevan Weather Bureau and the University of Yerevan, made geographic, petrographic, hydrogeological, soil, and biological explorations of the territory. They also collected data on mineral resources and construction materials.

In 1929-1933, reports of the expedition “Basin of Lake Sevan (Gokcha)” were published in three volumes (6 books in total, in 1000 copies each, with tables of contents in French and summaries in English). They included 38 maps (geological, soil, vegetation), photos, and chemical analysis tables. The Armenian Highlands covered by lava fields with several landforms made by repeated eruptions mostly in the Quaternary period. Basic andesite-basalts and some acidic lava flows seems to look like one of the formations in Iceland. Also discovered the importance of groundwater for the lake water balance. General suggestion was to limit drawdown of the lake, and combine its usage with groundwater runoff from the Aragats, in order to preserve the stability of the Sevan ecosystem.

In 1931, construction of irrigation system and power stations began on Hrazdan river (former Zanga) – the only river flowing out of the Lake Sevan. This was the time of the first Soviet “five-year industrial plan”. The lowering of the lake water table later has caused environmental problems. The progress of the academic expedition has much influenced the government decision to establish the Transcaucasian Branch of the Academy of Sciences of the USSR (1932-1933), divided later into three national Academies. Konstantin N. Paffenholtz (1893-1983) investigated the Lake Sevan at the same time (1927-1930). The Geological Committee (Survey) of Russia and prospecting survey organized his expedition. In 1934, Paffenholtz presented book “The basin of Lake Gokcha (Sevan): (geological outline)”, with another concept of the lake origin, lava formations and its age. The discussion between two points of view has aroused. This made Alexander P. Guerassimov (1869-1942; head of the expedition, and the editor-in-chief of the Guidebook compiled by Paffenholtz for the 17th session of the International Geological Congresses in USSR, 1937) to add both views.

Rocks and ores collected by the Transcaucasian academic expedition handled to the Peter the Great Geological and Mineralogical Museum of the USSR Academy of Sciences in Leningrad. In 1934, the Academy moved to Moscow, and now 129 original samples and 79 thin sections are in the Ore and Petrographic Museum of the Institute of Geology of Ore Deposits, Petrography, Mineralogy and Geochemistry Russian Academy of Sciences.

NERY DELGADO (1835-1908): THE DIPLOMATIC DIMENSION OF A GEOLOGIST'S CAREER

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This paper focuses on the diplomatic activities, both formal and informal, of Nery Delgado (1835-1908), a military engineer turned geologist that served for about 50 years in the Portuguese Geological Survey (PGS), created in 1857 as part of the cartographic program of the Ministry of Public Works, Trade and Industry, an emblematic power structure of Portuguese liberalism.

In recent years, increasing attention has been paid by both specialists in science and technology studies (STS) and in international relations (IR) to the relationships between science, technology and diplomacy, especially after the Cold War. In this context, nuclear power, environmental issues, agriculture, fisheries, telecommunications, and infectious diseases emerge as areas that have significantly enlisted scientific and technical expert advisors and mediators, often in complex international negotiations, with the greatest economic and political impact. But from the historical point of view, the involvement of science in diplomacy has deeper roots as the case of Nery Delgado shows. Throughout the second half of the 19th century, his work as a Survey geologist operating within State bureaucracy was not restricted to geological research and map making, but encompassed a variety of occasional mediating political roles. In a period characterized by the tension/complementarity between nationalism and internationalism, the diplomatic dimension of his career took various forms: official representative of the Portuguese government in international events, scientific fora, and cartographic endeavors; mediator and negotiator between similar institutional structures; go-between in the dealings of colleagues and businessmen with the PGS and the Portuguese government.

By comparing his case with later ones analysed in recent literature, we argue in this paper that prior to the professionalization of expertise after the II World War, followed by the reversal in primacy between science and technology that occurred in the 1980s, the 'diplomatic' role of scientists was not that of an appointed advisor, working in this capacity on a permanent basis. The case of Nery Delgado also shows that in the second half of the 19th century, scientists' diplomatic functions were secondary to their main line of work, the practice of science, and accompanied the increasing bureaucratization of the State apparatus. More importantly, they took place in the context of diverse cultural presuppositions, according to which not only was the cultural primacy of science over technology, but also of the public over the private and of the disinterested over the interested; ultimately, prior to the erosion of certain ideas of scholar and public service, underlying and orienting scientists' self-representation and often action that prevailed until the first decades of the 20th century.

ROBERT BEDFORD (1874-1951): A UNIQUE CONTRIBUTOR TO INTERNATIONAL GEOLOGY FROM THE AUSTRALIAN OUTBACK

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Robert Bedford (1874-1951), based in the remote and tiny farming community of Kyancutta in South Australia, was a unique contributor to world geology, specifically in the field of meteorites and fossil archaeocyatha. Born Robert Arthur Buddicom in Shropshire, UK, he was an Oxford graduate who commenced study as a medical student before eventually graduating with an honors degree in physiology. He subsequently worked as a scientist in Freiberg, Naples, Birmingham and Shrewsbury as well as with the Natural History Museum, Kensington and the Plymouth Museum in the UK. After a business failure, Bedford changed his surname and migrated to Australia in 1915 with his second wife and two children; three more children were born in Kyancutta.

Bedford applied to enter the medical school at the University of Adelaide in 1920 but was rejected. The fact that he was undergoing divorce proceedings from his first wife at the time probably did not assist his application. Bedford then proceeded to act as an unofficial doctor in the Kyancutta area for many years; assisting in the birth of almost 100 children. At the same time Bedford was developing geological interests especially following the establishment of his museum in Kyancutta in 1929. This included material previously collected and stored in the United Kingdom before being sent to Australia.

Bedford was much more successful than geologists from the University of Adelaide in collecting material from the distant Henbury meteorite craters in the Northern Territory, during three separate trips in 1931- 33. He became an expert on meteorites with much Henbury material being sent to the British Museum in London.

Bedford is perhaps best known amongst geologists for his five taxonomic papers on the superbly preserved lower Cambrian archaeocyath fossils from the Ajax Mine near Beltana in South Australia’s Flinders Ranges with field work commencing in about 1932 and extending until World War Two. This research, describing 28 new genera and 93 new species, was published in the “Memoirs of the Kyancutta Museum”, a journal that Bedford personally established in 1934. These papers are regularly referenced today in international research dealing with archaeocyaths.

During the 1930s, Bedford fell out with the scientific establishment in South Australia and in particular with Sir Douglas Mawson, who was not only Professor of Geology and Mineralogy at the University of Adelaide, but also a former President of the Royal Society of South Australia, President of the Australian and New Zealand Association for the Advancement of Science for five years in the 1930s, and the long standing Honorary Curator of Minerals at the South Australian Museum. Consequently Bedford was denied membership of the Royal Society of South Australia and access to its scientific journal, a fact that led to establishment of his own scientific journal. Given the antagonism between Bedford and his South Australian geological colleagues, Bedford sold most of his archaeocyaths, in his later years, to Princeton University in the US including many type specimens. However, the specimens from one of his archaeocyath papers, are today housed in the South Australian Museum in Adelaide.

FOSSILS, MAPS, MUSEUMS AND COLLABORATION: KEYS TO SUCCESS IN MURCHISON'S 1845 FIELD CAMPAIGN IN SWEDEN

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The first half of the 19th century was a time of rapid evolution of the discipline of geology including the construction of the geologic time scale. One of the main contributors to the construction of the Paleozoic portion of the time scale was Roderick Murchison (1792–1871). He began his geologic research in Britain in the 1820s, but later traveled extensively in Europe, Russia and Scandinavia, during which he mapped large regions of Paleozoic stratigraphy. An important product of that work was the two-volume book entitled *The Geology of Russia in Europe and the Ural Mountains* (1845) which included a remarkably detailed geologic map of much of Europe, western Russia and Scandinavia. The map synthesized not only the results of his own extensive fieldwork but also the observations of a number of other scientists. Key to the rapid progress made by Murchison was the application of the biostratigraphic approach developed by William Smith (1769–1839) where fossils were used to correlate and identify the age of strata. By this means, Murchison was able to correlate the stratigraphy of new territories with the well-known localities in Britain. Also key to the rapid progress made by Murchison was a research methodology that he used throughout his career. First, prior to a campaign, he corresponded with other scientists who had knowledge of the regions he intended to visit. Those scientists informed him of crucial fossil localities, and provided logistical advice for undertaking the fieldwork. Second, he arranged to have traveling companions who could assist with the fieldwork, and confirm his findings. In the case of the Sweden campaign, the traveling companions either had local knowledge, for example the Swedish naturalist Sven Lovén, or specialized knowledge, notably the French paleontologist Edouard de Verneuil. Third, the routes his campaigns took were typically influenced by existing geologic and geognostic maps that he had acquired prior to departure or during the campaign itself. In the case of his fieldwork in Sweden, the geognostic map prepared by Wilhelm Hisinger was especially useful, and with its assistance Murchison was able to predict where he might find fossiliferous Paleozoic strata along his route. Fourth, Murchison always took the opportunity to visit museums containing fossil collections, such as those in Stockholm and Wisby. Those collections provided a systematic view of the fossils that occurred in a district and thereby provided him with crucial supprting information for his geologic mapping. And finally, once the field season came to an end, Murchison announced his findings at the earliest opportunity in scientific venues such as the British Association or the Geological Society of London. He also published his findings in journal articles and in books such as *The Geology of Russia* (1845) and *Siluria* (1854). Murchison's field campaign in Sweden in 1845 provides an excellent example of his well-honed research methodology in action.

JAN SAMSONOWICZ (1888 – 1959) OUTSTANDING POLISH EXPLORER AND EDUCATOR OF THE SEVERAL GENERATIONS OF GEOLOGISTS

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He completed geological studies in St. Petersburg in 1914. After returning from Russia in 1915 Samsonowicz took a job as an assistant in the Department of Geology of the University of Warsaw, where he made geological investigations of the Holy Cross Mountains. Once the Polish Geological Institute was created in 1919 he took a job as editor of scientific publications. He discovered deposit of hematites and siderites in Rudki near Nowa Słupia in 1922, where *Staszic* mine was opened. In the same year he discovered a Neolithic mine of the Jurassic striped flint in Krzemionki Opatowskie. The Krzemionki complex is an example of the most advanced prehistoric mining technology in the World scale, proposed as the UNESCO heritage site. He also discovered phosphates deposit in Rachów on the Vistula River. Their mining exploitation started in 1924. In 1935 he was appointed professor and head of the Department of Paleontology at the Jan Kazimierz University in Lvov. In the years 1935 – 1938 he conducted geological studies in Volhynia. First results of these studies indicated possibility of existence of the Upper Carboniferous Basin. The hard coal deposits discovered by him are still being exploited in Poland and Ukraine. After the war he organized the Faculty of Geology at the University of Warsaw. Together with prof. M. Książkiewicz published *Outline of geology of Poland,* the first textbook on regional geology of Poland. He was also real member of the Polish Academy of Sciences and Chairman of the Polish Geological Committee, as well as organizer and head of the Department of Geological Sciences in the years 1956 – 1959.

L. A. SPENDIAROV PRIZE

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L. A. Spendiarov Prize is the most prestigious award for geologists from all over the world. It is awarded once in four years to the geologist from the country where next session of International Geological Congress takes place.

Leonid Afanasievich Spendiarov was born in Kakhovka (Crimea), 1869. In 1987 his family has moved to Simferopol, and Leonid got primary education in local gymnasium which he graduated in 1889. The same year in autumn he entered the Department of Natural Sciences of the Faculty of Physics and Mathematics of Moscow University. In 1894 he has brilliantly graduated from the University with golden medal and title of candidate of agricultural sciences.

During his education he became interested in mineralogy and achieved such successes that on recommendation of an outstanding Russian geologist Franz Yulevich Levinson Lessing, stayed at the university for conducting scientific researches in that field of knowledge. Living far from his historical motherland, L. A. Spendiarov dedicated his geological researches to the study of volcanic rocks of Mount Aragats, Kotayk Province and surroundings of Yerevan. His first scientific work was carried out so brilliantly that in 1895 scientific council of the University of Dorpat awarded him the second scientific degree: candidate of mineralogical sciences.

In 1896 the Ministry of Agriculture sent L. A. Spendiarov to Vienna to study geology and soil science and their use in agriculture, and he went there with his wife. In 1897 he started working in Paleontological Institute of Vienna. He carried out many scientific excursions in the surroundings of Vienna and Bohemia and processed the material which he collected earlier in Crimea and the Caucasus for his future master’s thesis.

In reference to the fact that the VII session of International Geological Congress was scheduled in autumn 1897, L. A. Spendiarov leaves to homeland to organize scientific excursions in the Caucasus with his teacher F. Yu. Levinson-Lessing for delegates of the Congress, leaving his wife and newborn son in Vienna. Unfortunately that trip became fatal for him. During one of the routes, the carriage in which Leonid Afanasievich was travelling, overturned, and the passangers could hardly get out from under it. His left arm was covered in blood. His arm was washed and wrapped, and he continued examination of scheduled routes and the next day participated in the ceremony of the opening of Congress. However he passed away in the evening...Now it is difficult to know the reason of such a quick death. But his father and son have also died because of small cuts. Possibly Leonid Afanasievich had inherited weak immunity and died because of contamination of blood through the wound.

At the request of L. A. Spendiarov's father and wife, Geological Commitee of Russia made a decision about the establishment of prize after his name from the money contributed for that purpose bank in St. Petersburg by his relatives. For the first time L. A.

Spendiarov Prize was awarded during the VIII session of the Congress in Paris, 1900. It was awarded to A. P. Karpinski.

Since 1900, 28 sessions of International Geological Congress have taken place (in 1944 there wasn't a session because of the 2nd World War). In 1922 and 1926 the government of the USSR confiscated Fund, and in 1968 the prize hasn't been awarded because of occupation of Prague by the Soviet army, where the 23th session was taking place. Thus 25 best geologists from all over the world were awardedthat prize for more than 100 years.

120 years have passed since the day of Leonid Afanasievich Spendiarov's tragic death but his name and prize have forever gone down in history.

ACADEMICIAN SERGEY SERGEEVICH SMIRNOV – OUTSTANDING SOVIET GEOLOGIST AND MINERALOGIST

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Sergey Sergeevich Smirnov (1895-1947) belongs to the pleiad of eminent scientists who have made a major contribution to the development of natural sciences. Of particular value are his studies in the field of mineralogy, geology of ore deposits and metallogeny. The scientist took an active part in the discovery of a number of tin ore deposits, as well as deposits of arsenic, silver, and others.

After graduating from the Petrograd Mining Institute in 1919, Smirnov S.S. - a gifted mineralogist, excellent diagnosist - devoted his life to studying the vast territories of the country: the Southern Urals and the Southern Baikal region (1924-1925), the Eastern Transbaikal region (1925-1931). Since 1933 he worked in unstudied and remote areas - Kolyma, Chukotka, Primorye. In 1926 S.S. Smirnov made an important discovery - he discovered grains of cassiterite in the Transbaikal lead-zinc ores. This finding served as the basis for the scientist's conclusion about the possibility of commercial tininess of sulphide deposits. In subsequent years in the confirmation of this forecast, large tin-sulfide deposits were discovered in Primorye, Magadan, Chukotka and Khabarovsk regions.

The results of scientific research by Academician S.S. Smirnov were published in 70 articles and several monographs. In the classic monograph "Zone of Oxidation of Sulfide Deposits" [1], the author develops search criteria that allow researchers to judge the nature and approximate composition of primary ores by the oxidized surface yields of the ore bodies. In the capital work "Polymetal deposits and metallogeny of the Eastern Transbaikal region" [2], the author first presented vast material of mineralogical and geological study of more than 500 deposits, distinguished various types of polymetallic deposits, divided the region into three ore-bearing belts: polymetallic, tin-tungsten and molybdenum-gold. The publication "Northeast Asia, its metallogeny and tininess" [3] for the first time provides a review of the metallogeny of the territory where the Verkhoyansk-Kolyma tin belt was identified.

In 1946 Academician S.S. Smirnov was awarded the Stalin Prize for identification of the raw material base, which provided the development of tin industry in the country. In honor of the scientist, the mineral is named after Smirnov - smirnovsonite, as well as a polymetallic deposit in Transbaikalia.

VLADIMIR LODOCHNIKOV AND RUSSIAN PETROGRAPHIC SCHOOLS

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It is 130 years since the birth of Vladimir Lodochnikov, one of the brightest and noticeable Russian petrographers of the first half of the 20th century. He was an expert in rocks and minerals optical diagnostics, a versatile researcher who dealt with petrography, mineralogy, crystallography, meteoritics, physical chemistry, etc., and a talented teacher whose books had been a desktop for Russian petrographers for more than 80 years.

Vladimir Nikitich Lodochnikov (Vartan Mkrtichevich Gaikchyan) was born on May 14, 1887 in the North Caucasus, near Stavropol city, in the Armenian merchant family. In 1916 he graduatedwith honors from the St. Petersburg Mining Institute. His teachers were E. Fedorov, V. Nikitin, D. Mushketov, K. Bogdanovich. His professional activities were connected with the Russian Geological Committee and the Mining Institute in Leningrad.

Lodochnikov conducted geological surveys in the North Caucasus, Altai and Eastern Siberia, petrographic studies in the Voronezh crystalline massif, Tarbagatai Ridge (Altai), East Sayan, Kyrgyzstan and Iran. He improved the technique of microscopic studies, created methodical textbooks, held consultations on petrographic methods in the several Geological Institutes, and often traveled to Moscow, Irkutsk, Tbilisi, Yerevan etc. for lectures and consultations on petrographic methods. Also, he was the editor of geological maps and reports.

In parallel with the scientific researches Lodochnikov in 1922-1930 was engaged in pedagogical work at the Leningrad Mining Institute. Among his students are the world famous scientists: D. Korzhinsky, V. Sobolev, Yu. Bilibin, Yu. Polovinkina and others.

Lodochnikov's special talent manifested itself in the preparation of textbooks on petrography. Such books as "Bases of microscopic methods for the study of crystalline materials", "Most important rock-forming minerals", "Petrology for the non-specialists " are notable by the original author's style of "confidential conversation", contain original methodic in the field of optical petrography, differ by the simplicity of presentation with a huge amount of information. A small-volume reference book "Most important rock-forming minerals", published in 1933, contained a description of 300 minerals grouped according to the magnitude of the refractive index (the Lodochnikov groups), recommendations for their determination in thin sections. The book had 5 editions, the last in 1974. And today, practically every petrographer constantly uses this unique reference book.

In autumn 1941, when German troops approached Leningrad, Lodochnikov and his family, like other professors of the Mining Institute, were evacuated to Kislovodsk (North Caucasus). In 1942 he fell seriously ill, and was unable to leave the city during its occupation by German troops. He died in Kislovodsk from exhaustion on January 11, 1943, two days after the city was freed. After the war, the Lodochnikov Ashes were moved to the Pantheon of Armenia in Yerevan.

The main petrographic schools in Russia are in Moscow, St. Petersburg, Yekaterinburg and Novosibirsk. They differ in scientific idealogy and methodology, have different views on the ratio of igneous and metasomatic processes, the role of contamination and mixing of magmas, etc. However, among the founders of these schools, the name of Vladimir Lodochnikov is always at the place of honor.

CONTRIBUTIONS TO MARINE GEOLOGY IN BRAZIL: THE WORKS OF ORVILLE ADALBERT DERBY (1851-1915), RICHARD RATHBUN (1852-1918) AND JOHN CASPER BRANNER (1851-1922)

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Until today the oceans and seas have not been more broadly studied by the History of Geology in Brazil. This paper is part of a project that starts with the international initiatives and its repercussions in Brazil regarding the British H.M.S. Challenger (1872-1876) and the German Meteor (1925-1927) Deep-Sea Expeditions −which are landmarks in the historiography of geological oceanography−, and it progresses until the early 1950s, when research patterns of the oceans were profoundly altered, consequently and gained greater prominence in the international science and technology policies of the postwar period, and which led Brazil to create the PaulistaInstitute of Oceanography (1946) andthe National Research Council (1951, currently CNPq). With regards to Brazil, the geological studies on the different marine deposit environments were undertaken in the late nineteenth century, particularly by American geologists conducting research in the country, such as Orville Adalbert Derby (1851-1915), Richard Rathbun (1852-1918) and John Casper Branner (1851-1922). This paper focus on their contribution to marine geology in Brazil. In several studies, Orville Derby dated rocks found around the Bay of Todos Santos, Bahia as Cretaceous. They were seen as evidence of a preterit Cretaceous basin, constituted mainly by gneiss, which he thought reached the south, covering areas that were already submersed. Generalizing his observations, he considered that this geological formation corresponded to several other present features such as the Rio de Janeiro, Santos and Paranaguá bays. Mineral depositional resources in coastal environments, such as the monazite sands− source of thorium and rare earths− have aroused national and international interest since the late nineteenth century and were also studied by Derby and Lee. Following these works, one the first CNPq initiatives in the 1950s was a geological survey project covering the Rio de Janeiro, Espírito Santo and Bahia coasts to determine monazite concentration, considered vital to Brazilian nuclear industry projects of the time, specially on sandy coastal plains and preterit beaches. Brazilian oceanic islands also attracted research interest by the Challenger as well as by the Brazilian Imperial Geological Commission, besides the expeditions by the Rio de Janeiro National Museum. For instance, Richard Rathbun, from the American Ichthyological Commission, travelled through the Itaparica island to investigate the existence of supposed coal deposits, to map coral reefs and to check its geological formation of Cretaceous rocks in fresh water environments. Branner, who took part in Hartt and Agassiz's expedition to Brazil in the nineteenth century, and directed the Brazilian Northeast Stanford Expedition, published some sixty papers about many subjects: coral reefs, Fernando de Noronha island, oil occurrence, Geological Map and a "Elementary Geology prepared with special reference to Brazilian students and to Brazilian Geology", with a chapter on ocean geological processes. Other works discussing these North American contributions related to marine geology were conducted since the end of nineteenth century in the Rio de Janeiro National Museum and in the institutions created such as theGeological and Mineralogical Survey of Brazil (SGMB) in 1907.

SOUTH AFRICAN GEOLOGIST ALEX L. DU TOIT, PIONEER OF CONTINENTAL DRIFT, IN THE CAUCASUS (17th IGC, JULY, 1937)- DIARIES AND PHOTOGRAPHS OF AN EXCURSION

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On 12th June 1937, South African geologist Alexander Logie du Toit (1878-1948) departed from Johannesburg on his way to Moscow for the 17th International Geological Congress. After 21 short flights by seaplane, he arrived in London 7 days later, and after a week in UK, he crossed the Channel by ferry, and travelled by train from Rotterdam, arriving in Moscow, 4 days later, on 30th June.

On the 1st July, he departed on the pre-IGC Conference excursion to the Caucasus, by train. The 16-coach train went south of Moscow through Rostov-on-Don, and by 3rd July had reached the thermal springs and resorts of Mineralnye Vody. From here they went by electric train through Piatigorsk along the flanks of Mount Beshtan, where the first stops of the excursion were made to see the contact between a laccolith and Mesozoic rocks, to Kislovodsk, and then to the frontier town of Georgia, Ordzhonikidze (now Vladikavkaz), where they were given a rousing reception. The excursion then proceeded by bus through Parsanour and Mtzkhetha, to Tbilisi, visiting the Geological Museum and University. The expedition continued to Kazakh (Qazax), and into Armenia, with stops in Dilijan and Sevan, before ending up in Yerevan. From Yerevan the return to Moscow (starting 19th July) was by train back to Tbilisi, and then along the Black Sea coast through Sokhumi, Payrtskhi Cathedral, Gagry and Sochi. Du Toit then attended the 17th IGC in Moscow, and the post-conference excursion to the Yenisei River, after which he also visited various institutions and museums in Leningrad (St Petersburg). He departed on 3rd September by plane from Moscow, and after 27 short flights, he ended his epic, four month journey, reaching Johannesburg on 17 September 1937.

Du Toit kept a detailed daily diary, an excursion notebook, and a social diary, where he recorded sketches of people and objects, and snippets of music. He also took many photographs, and meticulously recorded on his negatives the date and location of what was pictured. His notebooks and photographs provide a uniquely detailed picture of what it was like to travel to the IGC, and participate in its excursions, 70 years ago. During his stopover in UK before the IGC, he had visited his publisher Oliver & Boyd in Edinburgh, to finalize printing and distribution of his book “Our Wandering Continents” (1937) in which he strongly supported continental drift. His geological observations in the USSR, which were included in his notebook, including comparisons of Carboniferous and Permo-Triassic Angara and Caucasian flora with Karoo *Glossopteris* flora, came too late to be incorporated into his book.

THE ABAMELEK-LAZAREVS AND URAL PLATINUM

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The Lazarevs, come from an Armenian noble family, had owned plants at the Urals during about 150 years since 1771 till 1918. The Lazarevs acquired dominion in the Urals appeared due to purchasing of the Stroganovs' patrimony. In 1778 I.L. Lazarev acquired the property of the baron G.N. Stroganov heirs. The mining works includes iron, cast-iron, and copper smeltery and coal production. In 1862 Kh.I. Lazarev directed the control of the works to his son-in-law, prince S.D. Abamalek (since 1894, the Abamalek-Lazarevs). S.S. Abamalek-Lazarev (1857-1916), a graduate of historical-and-philological department of St. Petersburg University and dragged archaeologist, played a great role in the development of platinum industry. In 1882 S.S. Abamalek-Lazarev organized and financed scientific expedition to the Middle East. V.D. Polenov, a painter, and A.V. Prakhov, an art historian, took part in the voyage. Young S.S. Abamalek-Lazarev firstly visited the Urals in 1878, and after his father's death he devoted his life to the management of his Ural domain. He actively explored his dominion and specific mining industry; based on statistic data he made an analytic report. Though he hadn't got technical background, the prince quickly studied the works and modernized them due to his great erudition and diligence. In 1895 S.S. Abamalek-Lazarev was appointed a member of the Mining Council of Ministry of Trade and Industry; he took part in the 19th Forum of Ural *Mining* Producers (1901). He initiated the invitation of Swiss professor Louis-Claude Duparc (1866 – 1932) to discover new platinum placers and original sources. Since 1900 till 1916 L. Duparc and his co-workers, F. Pirs, G. Sig, O. Gross, and M.N. Tikhonovich, had been mapping and searching platinum deposits and placers. Russian geologists such as A.P. Karpinsky (1840), E.S. Fedorov, A.M. Zaitsev (1898, 1899), and N.K. Vysotsky (1903, 1913) continued with L. Duparc's researches of the Uralian Platinum Belt in close cooperation with owners of mines. S.S. Abamalek-Lazarev supported the group with engineering. In the result of the works numeral platinum placers and mineral occurrences were discovered. Since 1912 L. Duparc carried out geologic mapping of Nikolae-Pavdinskaya Dacha. In 1916 the Geologic Map at a *scale* of 1:50,000 and Geological Report (L. Duparc, O. Gross) was published with the support of both S.S. Abamalek-Lazarev and Society of *Mining* Producers. After S.S. Abamalek-Lazarev's death (1916) Duparc's group discontinued its researches in the Urals. During the works in the Urals, the scientists published about 70 papers devorted to the Uralian gabbro-pyroxenite-dunite complex and associated mineral deposits (Levinson-Lessing, 1935). The monograph «Le platine et les gîtes platinifères de l'Oural et du monde» (1920) about Uralian platinum was published in co-authorship with M.N. Tikhonovich. This monograph summed up long-term investigations of L. Duparc and his group and was the first generalized work in the field of platinum geology, petrography, and chemistry; it described laws governing locations of placers and mineralization occurrences, as well as methods of PGM mining, processing, and metallurgy. The information obtained by Duparc's group was used as the basis for full-scale searching conducted in the North Urals at the Soviet period.

FRANCISCO LUÍS PEREIRA DE SOUSA (1870—1931): THE SCIENTIFIC LIFE OFA 'EVERYDAY MAN OF SCIENCE' IN PORTUGAL IN THE BEGINNING OF THE 20th CENTURY

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The present paper concerns the scientific life of Francisco Luís Pereira de Sousa (1870-1931), a Portuguese military engineer that transformed himself into a geologist. Pereira de Sousa worked most of his life in the Portuguese Geological Survey but he was also a professor of geology at the Faculty of Sciences of the University of Lisbon. He travelled frequently to Paris where he worked in the Laboratory of Mineralogy of the Musée d'Histoire Naturelle where he was mostly influenced by François Antoine Alfred Lacroix (1863-1948). Pereira de Sousa acknowledged Eduard Suess (1831-1914) theories on tectonics, and he joined the revival of enthusiasm about the possible existence of Atlantis shared by some members of the international geological community in the beginning of the twentieth century. Pereira de Sousa used a wide-ranging set of concepts and theories developed by foreign geologists and applied them in his own research on the geology of the Portuguese mainland, namely his hypothesis on the Lusitanian-Hispanic-Moroccan oval-shaped basin. If we approach Pereira de Sousa scientific life as a 'biography in context', it is possible to shed some light into the routine of an 'everyday man of science' in Portugal in the beginning of the 20th century, whilst enlightening questions related to the circulation and appropriation of geological knowledge in the country.

JAMES HECTOR (1834-1907) AND THE BIRTH OF THE NEW ZEALAND GEOLOGICAL SURVEY

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James Hector studied for a medical degree (which included papers in botany and geology) at the University of Edinburgh in Scotland. Immediately after graduation he joined the Palliser expedition (1857-1859) exploring British North America and looking for a pass through the Rocky Mountains. Hector distinguished himself on the expedition, producing the first reconnaissance geological map of what is now western Canada. He spent much of 1860-61 in London, making contacts at the British Geological Survey, Royal Botanic Gardens at Kew, newly developing museums, the Royal Society and other scientific organizations. He left Britain in late 1861 to take up a position as Provincial Geologist in Otago, New Zealand, and was appointed to set up the New Zealand Geological Survey in 1865.

Hector was the first scientist appointed by the New Zealand government, and was consequently expected to take on a wide range of scientific and technical responsibilities. In addition to the Geological Survey, he was soon in charge of the Colonial Museum, the Colonial Botanic Gardens, the Colonial Observatory and the New Zealand Institute (now Royal Society of New Zealand) as well as being responsible for weather recording and forecasting (Nathan 2015). Geological mapping by Hector and his staff led to the publication of the first national geological map in 1869 with revised editions in 1873 and 1884 (Nathan 2014). Hector remained a key figure on the New Zealand scientific scene for almost forty years until his retirement in 1903.

The 150th anniversary of the founding of the New Zealand Geological Survey (now GNS Science) was celebrated in 2015.

ON THE TRAIL OF HERMANN ABICH IN ITALY: A JOURNEY THROUGH THE ITALIAN VOLCANOES

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During the XIX century, Italy represented a key-area for numerous foreign scientists, both geologists and naturalists, who spent their time travelling through the most typical and significant geological sites. These scientists produced several works that were widely disseminated, being written in French, German, English and Russian.

Among the most important researchers that worked in Italy during this period, is worth to mention Otto Hermann Wilhelm Abich (1806-1886), one of the most outstanding German geologists of the XIX century. Abich, following the advices of Leopold von Buch (1774-1853) and Alexander von Humboldt (1769-1859), visited Italy for the first time between 1833 and 1839, devoting himself to the study of active and extinct volcanoes. During these years, he carried out numerous topographical measures, and mineralogical and petrographic analyses. He published a series of excellent scientific papers, describing the structure, activity and history of Etna, Vesuvius, Alban Hills, Pontian Islands, Phlegraean fields, Roccamonfina, Vulture and Stromboli volcanoes. Abich went back to Italy again in the years 1856-1857, focusing his research especially on the Vesuvius after the volcanic activity started in December 1855.

These short research periods spent in Italy by Abich are well testified by some manuscripts and original drawings discovered in the Archive of the Geological Survey of Italy; interestingly none of the Abich published biographies mention these travels.

Our work retraces the journeys made by Abich in Italy during which he built profitable relationships with Italians geologists of that period such as Leopoldo Pilla, Gaetano Giorgio Gemmellaro, Arcangelo Scacchi, Guglielmo Guiscardi, Luigi Palmieri and others. With them, he visited active and extinct volcanoes of Central and Southern Italy, contributing to the development of volcanology as a scientific discipline and bringing into question the Von Buch's theory of "Craters of Elevation".

An undisputed merit of Abich was the thorough description of geomorphological features of volcanic edifices and related lava flows. He also devoted particular attention to the cartography of the studied territories, supported by accurate barometric and trigonometric measures, in order to estimate the height and geometry of the eruptive edifice.

His formation of chemist and mineralogist allowed him to define the petrographic characters of lava bodies and to characterize the gases emitted during secondary volcanic events.

Noteworthy are some original drawings found in the Archive of the Geological Survey of Italy; they consist of various illustrations, represented by topographic reliefs and Vesuvius landscapes in watercolor.

The aim of this work is to shed light on the Abich's Italian period that gave him solid cultural and scientific basis on which he built his reputation and career,becoming one of the most important European geologists of the XIX century and the first geologist who explore the Ararat and Caucasus regions.

C.A.M. KING, PIONEERING (WOMAN) GEOMORPHOLOGIST

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British geomorphologist Cuchlaine A.M. King was one of the first women to pursue an academic career in the scientific study of landforms. Despite being an intensely shy and extremely private person, she had a tremendously successful career. Born in Cambridge, England, in 1922, King's interest in the natural world was strongly influenced by her family life. Her father, W.B.R. King, originally from the Yorkshire Dales, was a decorated military geologist who served in both world wars and became an eminent Cambridge University geology professor. Young Cuchlaine loved the outdoors and particularly enjoyed hiking and camping on their visits to the family home in North Yorkshire. Attending all-girl schools may have also encouraged in King the notion that no lines of inquiry were closed to girls.

King received her undergraduate degree in physical geography from Cambridge University in 1943, then entered the Women's Royal Naval Service for the remainder of World War II. The war experience furthered the notion that women were fully capable of mastering traditionally male occupations. After the war, King returned to Cambridge to pursue graduate studies and, for her doctoral thesis, completed in 1949, extended research on coastal sand transport that was initiated in preparation for the D-Day landings. King joined the geography faculty at the University of Nottingham in 1951. Her interests soon expanded from coastal into glacial geomorphology and quantitative methods. She maintained a deep commitment to field work, and preferred working in remote glacial regions. She rose to the rank of professor, authoring more than 55 articles on coastal, glacial, quantitative, and regional geomorphology. She is best known, however, for her numerous and widely used books that cover a variety of topics from oceanography to numerical analysis in geomorphology. Her body of work demonstrates that she stayed abreast of the scientific developments in her field, and that she was fully committed to communicating the results of her work to others.

JOSEPH PENTLAND AND GEORGES CUVIER:A FRENCH - BRITISH ENTENTE CORDIALE

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Joseph Barclay Pentland (1797-1873) a forgotten pioneer in the osteology of fossil marine Reptiles, was an Irish geologist who came to Paris as student at the University and at the Ecole des Mines. As a young fellow, he hiked during 17 weeks, some 2500 English miles journey in France to study the geology. In 1818, he worked with Georges Cuvier (1769-1832) at the Muséum national d'Histoire naturelle. He became one of his assistants and a good friend of Cuvier's family members, including Clementine Cuvier, the beloved daughter of the great French naturalist.

He exchanged letters with William Buckland and William Conybeare on the probable habits of the Jurassic marine Reptiles and he played an important role in a French-British connection in fossil vertebrate research.

Pentland visited Italy in 1822, with Mr. Ricketts, late member of the Supreme Council of Bengal, who paid his expanses. He collected numerous vertebrate fossils for Cuvier and sent letters to his friend William Buckland to inform the British paleontologists on new discoveries.

Pentland travelled to South America (Peru) as private secretary to Charles Milner Ricketts in 1826-1827; he studied volcanic peaks and visited the Titicaca lake; in 1828, he came back to France and to his work with Cuvier.

After the death of Cuvier in 1832, he worked with Charles-Léopold Laurillard and Achille Valenciennes cataloguing all the anatomical preparations of Cuvier's Cabinet.

He returned to South America in 1836 as Consul General in La Paz and stayed in Bolivia during three years, where he had the opportunity to make scientific works including a map of the Titicaca lake, and finding fossils of Silurian age at a height of 17.000 feet above the sea.

In 1845, he was back in Italy and made Rome his winter residence where he had many friends. He was selected to act as guide of the Prince of Wales on the two occasions of his visiting Rome. He was likewise for many years editor of Murray's Handbooks for Rome and Italy.

He died in London in 1873 and is buried in Brompton Cemetery, within a few feet of his old friend, Sir Roderick Murchison.

A photograph of Joseph Barclay Pentland has been recently discovered, a document which would have enjoyed his biographer the late William Sarjeant, a member of our INHGEO, a colleague and a friend to whom this lecture is dedicated.

PROFESSOR EDWARD RÜHLE (1905 – 1988), CREATOR OF THE POLISH MODERN GEOLOGICAL CARTOGRAPHY

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Graduated the Faculty of Mathematics and Natural Sciences of the Warsaw University. Based on researchers at Polesie he obtained Ph.D in 1939. In mid - 1938, he was employed at the Polish Geological Institute in the research group of the Volhynia, Podolia and Polesia. These studies were stopped due to the outbreak of war in 1939. During occupation Rühle wore nicknames of “Gozdawa” and “Zawrat” and on the command of Armed Combat Union (ZWZ) began to collect topographic maps. By mid-1942 the resources of the underground service were about 50 000 different maps. In 1942, the Geographical Service of the Home Army (AK) was reorganized, obtaining the code name “Shelter”. The main task of the newly created unit, to which Rühle was deputy, was the resumption of publishing works of the military cartography. After the war he was appointed plenipotentiary of the PGI director responsible for reconstruction works in Warsaw. Under his leadership *the Overwiew geological map of Poland* at the scale 1 : 300 000 was made. It was implemented from 1947 to 1953. In 1950, the other monumental work was also commissioned, titled *Geological Atlas of Poland* (completed 1962), under his scientific editorial supervision. In the years 1954 – 1966 Rühle was the director of Institute. At the time of his performance, the Institute was experiencing a period of true glory. His organizational abilities, made the right decision to create his own printing company which gave cartography and publishing issues unprecedented impetus. During his term of office, in 1956, the Institute formally start to elaborate*Detailed geological map of Poland* at the scale 1 : 50 000. His scientific output is 300 entries published in various fields and several thousand manuscripts. According to professor’s bibliography, he published 55 articles on geology of Tertiary and Quaternary, 56 articles on cartography, and published 60 maps of various scales.

ALEKSANDER MICHALSKI (1855-1904) AND HIS CONTRIBUTION TO THE DEVELOPMENT OF THE GEOLOGICAL MAP OF EUROPEAN RUSSIA (1892)

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The turbulent economic development of Russia in the early 1890s triggered the need for a deeper and more careful examination of raw materials. Many cartographic documents, necessary for business planning, were created at that time. The Geological Committee, set up in 1882, prepared for its 10th anniversary “The Geological Map of European Russia" („Carte geólogique de la Russie d'Europe éditée par la Comité Géologique”) in a scale of 1:2 520 000 (colour lithography, composed of 6 sheets measuring 56 x 66,7 cm each; the entire map: 167 x 132 cm). This map was a collective study conducted under the direction of Aleksander Karpiński. The authors included S. Nikitin, F. Czernyszev, H. Sokolov, A. Michalski, I. Muszkietov, E. Fiedorow, A. Sorokin, S. Simonowicz, A. Gurov, P. Armaszevsk, A. Konchin, N.Barbot-de-Marny, V. Ramsay and J. Sederholm.

One of the authors was a Polish geologist and paleontologist Aleksander Michalski (1855 - 1904) who developed the so-called section IV of the map (West Region). It covered the territory of the Polish Kingdom, located in the western part of Russia.

Michalski studied in the Mining Department of the Mining Institute in Petersburg from 1873 to 1878 and obtained a mining engineer diploma. He worked at the Mining Department in Petersburg and later at the Mining Institute’s Museum where he conducted geological and paleontological research as well as gathered significant collections. After the Geological Committee in Petersburg was founded, Michalski became its employee, initially as geological collection conservator, then junior geologist (1885) and senior geologist (1897). He was associated with this institution for the rest of his life, leading theoretical and practical studies, mainly in the Polish Kingdom and in European part of Russia. Michalski’s researches in the Polish Kingdom were focused on rock salt and oil deposits as well as examination of lands intended for the construction of railway lines. Between 1896 and 1901 he led cartography works in Krzywy Róg which resulted, among others, in discovery of new iron ore deposits. In 1904 Michalski assessed hard coal reserves in the Polish Kingdom.

Michalski published mainly in Russian scientific magazines and articles about ammonoids (Michalski was an expert in this area) printed in 1890 and 1898 are of particular note. Some of his works were also published in parallel Polish titles. Especially interesting and valuable are his articles printed in „Pamiętnik Fizjograficzny” (1885, 1887 and 1888). Michalski took also part in the works of the International Geological Congress in Zurich (1894), Petersburg (1897) and Paris (1900).

SPLENDORS AND SHADOWS WHICH IS ABOUT THE LIFE OF JAN WYŻYKOWSKI (1917 – 1976) AND THE DISCOVERY OF THE "GREAT COPPER" IN POLAND

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After the war he has studied at the Faculty of Mining University in Krakow. In 1946 – 1948 he held summer practices in mines and in the Polish Geological Institute (PGI), which allowed him the exploration of ore deposits in the Lower Silesia. On January 1951 he was transferred to PGI, where gradually all the works related to the issues of the ore exploration took over in the Ore Department based in Krakow. In the early 50's a research program for copper exploration began to crystallize in the area located north from Old Copper Basin and north from Wrocław. Such program was postulated by two heads of the Ore Department, R. Krajewski and A. Graniczny. The seismic profile was executed along the Bolesławiec – Głogów direction. The seismic profile aimed to determine the extent of Kupeferschiefer Zechstein formation at the Fore-Sudetic area. Wyżykowski has planned drillings along this profile line. The first three drillings did not indicate the possibility of success. Besides that, Wyżykowski researchers were illegal, because he drilled to the depth of 700 meters, which was about 300 meters deeper than he was allowed. The thesis of futility exploration works in this area started to dominate. Despite all these adversities Wyżykowski stubbornly strive to achieve the goal. A team led by him came across copper ore of industrial value 23 march 1957. In the borehole Sieroszowice IG 1, at the depth of 650 m, in the marls sediments occurrence of copper mineralization 1.4% was stated. The presence of rich copper mineralization was confirmed also in a nearby borehole S19 in Lubin. The history of the "great Polish copper has started". It was the biggest discovery of mineral deposit in the world in the 20th century - in one deposit is concentrated 10% of the world's copper resources.

GEOLOGICAL AND PALAEONTOLOGICAL STUDIES BY TEIICHI KOBAYASHI (1901-1997)

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Teiichi Kobayashi (1901-1996) is a major figure in the history of Japanese geology and paleontology. He was one of the founding members of INHIGEO, appointed at its first meeting in Yerevan, Armenia in June 1967. He was the first Vice-President of the International Union of Geological Sciences (IUGS) and also served as Vice-President of the International Paleontological Union (IPU).

He was a very productive scholar, publishing almost 800 papers and books on geology, paleontology and tectonics. He is best known for his work on the Sakawa Orogenic Cycle and its bearing on the origin of the Japanese Islands, which was published in 1941. His synthesis played a leading role in the development of modern tectonic ideas in Japan, before the introduction of the theory of plate tectonics in the 1970’s. He was awarded the Japan Academy Prize for this achievement in May 1951, then and now one of the most respected prizes Japanese scholars can receive.

After WWII ended, societal circumstances changed drastically in Japan. People who had formed part of the establishment in Japanese society were attacked, mostly for their political beliefs. Kobayashi was one of the targets. After the introduction of plate tectonics, Kobayashi’s Sagawa Orogenic Cycle is reconsidered new meanings.

Kobayashi started historical geology and tectonics on the Older Paleozoic in South Korea in 1926 and published the first paper in 1928. He continued to research the geology and paleontology of the Paleozoic in eastern and southeastern Asia and wrote on cephalopods and trilobites in Asia.

After WWII, 12 reconnaissance survey teams were sent out up to 1981. These missions brought success in collecting fossils and in establishing the local stratigraphy. The results were successively published in a series of 25 books with the title of “Geology and Paleontology of Southeast Asia” (Kobayashi, chief editor, 1964-1984). Papers contained such basic data as the description of stratigraphical sequences, their fossil content, local and regional geological structures, as well as synthesized tectonic histories of the countries concerned. These surveys greatly contributed to a better understanding of their geology.

THE MEANING OF MUSEUMS: THE BACKGROUND OF THE GEOLOGIST TEIICHI KOBAYASHI'S 'GEOSCIENCE' CONCEPTION IN THE 1940s

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When the geologist Teiichi Kobayashi (1901–1996) published an article on earth sciences education in 1942, he included not only geology but also astronomy and geophysics as teaching materials. During the post-war period he was engaged in establishment of the educational category *Chigaku*, namely 'geoscience', as an integrated domain of this kind of sciences. In this paper I examine the background of Kobayashi's conception of 'geoscience', focusing especially upon his experiences in the Smithsonian Institution and other natural history museums in the western countries (1931–1934). They possibly led him realize the importance of historicized geoscience concept and public education of the domain. In reality, Kobayashi contributed to the activities of the geoscientific division of the Tokyo Science Museum (now National Museum of Nature and Science) after his returning to homeland and his pupil geologists were at work in the museum. The museum was then supervised by the petrologist Seitaro Tsuboi (1893–1986). Additionally, the development of evolutionary theories of the universe and their popularization in 1910s–1930s Japan would be considered. Because it is highly possible that Kobayashi had be influenced by such evolutionary thoughts of the earth and universe in his school years in Kyoto.

PROFESSOR QIUSHENG ZHANG (IN MEMORY OF THE 30th ANNIVERSARY OF HIS PASSING)

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Professor Qiusheng Zhang (1929.8-1987.12), the most well-known geological professor at Changchun University of Earth Sciences, a top school of geology in China and now part of Jilin University, suddenly passed away on December 28, 1987 while travelling on Flight 938 from Sharjah, United Arab Emirates to Beijing. He contracted a local disease while on a field trip in Tanzania for an international conference, and developed life-threatening malignant malaria as a result. Aged 58 at the time, Zhang's passing shocked not only the geological world but also had a severe impact across China.

Amongst Zhang's impressive resume are numerous key roles, including: Director of the Institute of Mineral Deposits; Chairman of the Geologists Association of Jilin Province, China; China Working Group leader for both Projects 91 and 247, International Geological Correlation Program (IGCP), UNESCO; the first President of the International Working Group of IGCP Project 247 (1989-1990); and Member of the International Association of Mineral Deposits.

In addition, Zhang made many contributions to the development of geological sciences, including: recognizing the granitization of Jushan Group in Jiangsu Province, China; building the evolutional model and study method of the early Precambrian geological structural cycles of China; recognizing Paleozoic ophiolite in the eastern Qin Mountain region, China; proposing the Liaojitite Suite, a special eugeosynclinal facies of the early Proterozoic in Liaoning and Jilin Provinces, China; proposing deep liquid source beds underneath the ancient crust at continental margins; researching metamorphic cycles and associated mineral deposits in China; among many others.

As his master's student, the author of this paper describes Zhang's overloaded schedule in 1987, the reactions of his wife, postgraduate students and colleagues before, during and after his final trip to Africa, and his significant geological contributions.

A 'HIDDEN FIGURE': OSCAR NERVAL DE GOUVÊA (1856-1915), MINERALOGY & MEDICINE IN BRAZIL

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The engineer and physician Oscar Nerval de Gouvêa was a scientist and teacher who developed his career in Rio de Janeiro, Brazil. Although virtually unknown outside Brazilian borders – and still today poorly known even in his homeland –, he was quite prominent in his time, as testified by both a public school and a street in the metropolitan area of Rio de Janeiro named after him. Nerval de Gouvêa was born on September 15, 1856, in Rio de Janeiro and died in the same city on November 14, 1915. He studied engineering at the *Polytechnic School*, medicine at the *Faculty of Medicine*, and social sciences & law, all in Rio de Janeiro. Nerval de Gouvêa founded in 1898, with other colleagues, the *GymnasioBrasileiro*, a secondary school aimed at the education of women. Amongst other political and technical positions, he was a member of the Public Instruction City Council during Republican times (i.e., from November 1889 onwards), strongly supporting free schools. He was also an enthusiast and practitioner of Esperanto, having founded an Esperanto Club (*Brazila Klubo Esperanto*) on June 29, 1906, and serving as its 2nd Vice-president. He devoted his life to education. Nerval de Gouvêa was professor of geology and mineralogy at the *Polytechnic School*, which he joined after having presented, in 1880, a dissertation on Brazilian plutonic rocks for an academic contest; later (1911-12) he served as Director of that institution. He also taught physics and chemistry at the *NationalGymnasium*, and physics at the prestigious *PedroIISchool*, and authored a textbook on physics. What interests us most in this paper is the 'Table of Mineral Classification' he added as an appendix to the thesis he presented to graduate from the *FacultyofMedicine* on October 10, 1889. The link between geology and medicine is not at all unusual: medicines of mineral origin were well known and employed since earlier times, as medical professionals played a relevant role in the history of geological sciences. William Babington, one of the founders and later President of the Geological Society of London, even published a new system of mineralogy in 1799 (Duffin 2013). Nerval de Gouvêa's profile fits in one of the three types described by Angetter, Hubmann and Seidl (2013), namely: scientists who completed some form of both medical and geological studies at university. In medicine Nerval de Gouvêa's practice aligned with homeopathy (cf. International Homoeopathic Medical Directory, 1898) and he attended to patients privately, often *pro bono*. His involvement with both mineralogy classes and homeopathic practice could partially account for the production of his 'Table of Mineral Classification' inserted in a medical monograph. His classes at the *Polytechnic School* presented geology, and especially mineralogy, according to the more general conception of Natural History System of Classification developed by Friedrich Mohs in 1824. This had a deep effect on North American mineralogy because it was adopted, in 1837, by James Dana in his *System of Mineralogy* (Staples 1981). Due to the worldwide use of chemical classification, the focus on using classes, orders, genera, and species by the 'natural history' system progressively declined towards the beginning of the twentieth century. Nerval de Gouvêa's 'Table of Mineral Classification' is built on this notion. This paper will explore it, discussing its foundations and main features, in order to get an understanding of mineralogy and its connections in Brazil at that time, through the pivotal figure of Nerval de Gouvêa.

THE ACCADEMIA DEI LINCEI AND THE EARLY GEOLOGY AROUND THE YEAR 1630

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The Roman Federico Cesi founded the *Accademia dei Lincei* in 1603, the first scientific academy in Europe. The archives of this academy, for the most part stored at the *Bibliothèque de l'École de Médecine* of Montpellier (France), include manuscripts that deal with the proto-geology of the time. They show that a few 'academicians', like Federico Cesi, Fabio Colonna, Francesco Stelluti, Galileo Galilei, Cassiano dal Pozzo, Nicolas-Claude Fabri de Peiresc and Francesco Barberini, nephew of Urban VIII, were interested in the Earth sciences. Frenchmen friends of Peiresc (Gassend, Menestrier, La Ferrière, Naudé) had a similar interest and maintained close relationships with the *Lincei*.

Most of these scholars were favorable to the organic origin of fossils. Fabio Colonna understood that the glossopetraes were fossil teeth as early as 1616, half a century before Steno. In 1629, Claude Menestrier, who occupied in Rome the charge of librarian of Cardinal Francesco Barberini, studied the Monte Mario fossils, near Rome, which he observed under the 'tube of Drebels' – *i.e.*, the first microscope – and was convinced that they indicated the past presence of the sea in Rome. Peiresc contributed to the refutation of the 'giant' myth, showing that some of the so-called 'giants' were actually elephants. The *Lincei* investigated the fossil wood of Acquasparta (Umbria, Italy), whose drawings are now preserved in the "paper museum of Cassiano dal Pozzo" at Windsor (United Kingdom). Stelluti believed that these woods were formed spontaneously in the ground, an opinion apparently not shared by many. The *Lincei* paid also attention to the volcanoes, in particular to the terrifying eruption of Vesuvius in 1631, several accounts of which are preserved in the papers of the Academy at Montpellier. The *Lincei*, in particular Peiresc, imagined the Earth being full of cavities, where streams of 'fire', water and even air flew, being the cause of seismicity, volcanism and vertical tectonic movements.

The Galileo affair in 1633 threw some confusion among the members of the Academy, torn between their solidarity with the *Linceo* Galileo and their loyalty to the pope Urban VIII. Peiresc was secretly favorable to the Copernican theory; it is possible that Cardinal Francesco Barberini, nephew of the pope but cautious patron of the Academy, was also open-minded to this theory.

CONTRIBUTION OF EUROPEAN PALEONTOLOGISTS TO THE STUDY OF PALEOZOIC DEPOSITS OF THE ARMENIAN HIGHLANDS (XIXc)

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Generally paleontological studies of the Phanerozoic deposits of the Armenian Highlands, covering the western part of Turkey, a small part of southern Georgia, the territory of modern Armenia, the Nagorno-Karabakh Republic and the Nakhchevan Autonomous Region of Azerbaijan, are associated with the name of the "father" of the geology of the Caucasus, the German academician Herman von Abich (1806-1886). In the early 1840s he introduced the scientific term "the Armenian Highlands" in honor of the autochthonous Armenian people that inhabited this vast region from ancient times (Melik-Adamyan, Khachanov, 2011, 2016).

Seven years after the Devonian system was separated, the outstanding paleontologist, President of France Geological Society Edouard Verneul (1805-1873) was the first to discover the Devonian system in the Armenian Highlands and the vast Caucasus region, basing on H. Abich's collections of brachy-fauna from the light gray limestones near the village of Gnishik, Vayots -Dzor Marz, Armenia, and published a short article (Verneul Ed., 1846-1847; Paffenholz , 1948). It is noteworthy that from here H. Abich described a new species of brachiopoda *Cyrtiopsis (Spirifer) orbelianus Abich, 1858*, named after the ancient Armenian princely family Orbelyan. Later this species was also identified from Upper Devonian (Upper Famen) sediments of France, Belgium, Poland, Pamir (Abich, 1858; Melik-Adamyan, 2011, 2016).

In his fundamental monograph of 1878, on the basis of several dozen species of fossil invertebrate fauna from dark grey limestones, Abich pioneered to reveal the presence of the first Lower Carbonate (limestone), for the Crimean-Caucasian region and further - undivided Permocarbonate deposits, on the left bank of the Araks River, approximately 10km northwest of Julfa (the ancient Armenian city of Dzhuga), now the Nakhchevan region of Azerbaijan (Abich, 1878; Arakelyan, 1951).

H. Abich identified 10 new species of brachiopods, 4 new species of ammonoids and 11 new species of nautiloides, one of which, *Pseudotitanoceras (Nautilus) armeniacum (Abich, 1878)*, found from low-power (8m) ammonite layers, the scientist named after the autochthonous Armenian people, who from ancient times inhabited the Nakhchevan region, their historical homeland. To date, A.K. Grigoryan synchronizes these layers with the conodont biozone *Clarkina (Gondolella) leveni* and considers it within the volcanic Wuchiapinguian (Julfian) tier of the Upper Permian system (Zakharov et al, 2008; Sarkisyan, Grigoryan et al, 2006; Melik-Adamyan, 2016b).

In 1897 the Paleozoic era of the Julfa Gorge was explored by German and Austrian paleontologists F.Frech (1861-1917) and G. Arthaber (1864-1943). From the gray marls of the 1st zone in Julfa section (Guadalupian tier, Middle Permian) G.Arthaber named one of the new types of brachiopods, *Orthotetes armeniacus* in honor of the autochthonous Armenian people (Arthaber, 1900; Kasumzadeh, 2000).

Thus, since the late XIX century, this part of the Armenian Highlands has attracted the attention of leading European paleontologists and geologists.

HOW THE CAUCASUS BECAME ‘OUR’ CAUCASUS: FROM GEOLOGY TO ALPINISM

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In the beginning, alpinism was not merely the pursuit of sportive high performance. It originated from a combination of bourgeois activity and researching curiosity. Both aimed at gradually going beyond the limits of our knowledge. Far away from their offices, botanists and mineralogists made the mountain terrain their arena. What began in the Western Alps initiated by Bénédict de Saussure (1740-1799) in the second half of the eighteenth century was soon copied in other regions of the world. Saussure, at the same time, laid the foundation of field geology combining geology and terrain.

Travelers as well as geologists no longer made their way *through* but *into* the mountains, whereby these enterprises were motivated and justified by scientific objectives. Travels through the region that was soon conceived and referred to as a contiguous terrain named ‘Caucasus’ found expression in different accounts. From the 1860s, central European alpinists with an educated background in geography and geology felt that their ‘own’ mountains – the Alps – slipped away from them as an area of activity, because it was increasingly occupied by sportspeople. The huge mountain world between Black and Caspian Sea, however, seemed to offer an alternative. It was an area with ‘nothing in the way’, a challenge for European and Russian scholars. Building upon the seminal geological works on these regions by Hermann Wilhelm Abichs (1806-1886), alpinists created a new expertise by turning to the highlands of the Caucasus. As before in the Alps, the British Alpine Club, German geographical societies, the Austrian Geographical Society and the Alpine Society (Österreichischer und Deutscher Alpenverein) took part in the project to give the Caucasus a detailed, but also a consistent and opaque image. This current reached a climax with the accounts of the Munich alpinist Gottfried Merzbacher (1843-1926). Based on a plethora of visual and cartographical information, he raised awareness in Europe for a world region, which at the same time got caught between different geopolitical power interest. This paper will examine the intertwined histories of alpinism and geology as well as between field-science and cartography.

CLOSING THE IRON CURTAIN: HOW GEOLOGISTS IN GERMANY EXPERIENCED THE BEGINNINGS OF THE COLD WAR ERA

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Germany in winter 1945/46: Devastated cities, communication lines disrupted, refugees and foreign military governments, hunger and cold. As for geology: most institutions had been destroyed or severely damaged in World War II and the need for personal survival was uppermost in people's minds. The denazification process added to personal feelings of continuing insecurity. Travel was severely restricted by the need for a visa and political assessment to cross the borders between the inner German occupation zones.

Nevertheless, there were also first attempts to mend severed professional ties by contacting colleagues within Germany and outside, although sending letters tended to take weeks – the postal service additionally being hampered by censorship.

The geological institute of Berlin University, the Berlin Natural History Museum as well as the former *Reichsamt für Bodenforschung*, i.e. the national geological survey, were all in the Soviet Sector of the city. The latter was an especially large administrative body due to centralization of geological surveys under the Nazi regime. It seemed only natural to assume that – once matters had settled down a bit – Berlin would again play a vital role as a major center of geology in years to come. Consequently, and as far as logistically possible under the difficult circumstances of the time, publications and maps, paleontological specimens and geological information was exchanged, e.g., between Berlin and Hannover (within the British Zone) or Berlin and Tübingen (within the French Zone), and vice versa.

Over the next couple of years, however, matters of logistics did not become easier – to the contrary. Berlin colleagues reported increasing political pressure and many left eastern Germany to seek employment in the west. Those that remained were forced to abandon professional bonds with the western zones and several had to answer for their naïve assumption that they still were part of a common all-German geological "family". Whereas it seemed comparatively harmless, when one had sent a few fossil corals from Berlin on loan to Tübingen, those that had sent information on petroleum and ore deposits suddenly found themselves charged with espionage and high treason, facing imprisonment and potentially worse.

As a consequence, letters crossing the border became less and less frequent and geologists like everybody else settled in two different worlds separated by the so-called "Iron Curtain".

SOME FEATURES OF THE HISTORY OF GEOLOGY IN RUSSIA

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The history of geology was an integral part of geological researches in Russia in 19 c. The first Russian geologists studied European ideas at home universities and trained abroad. All Russian textbooks had introduction chapters on the history of ideas. The geology in Russia has been developed accepting or criticizing conclusions of foreign colleagues.

The history of geology originated in Russia at the beginning of the 20th c. Three geoscientists are well recognized as its leaders – Vladimir I. Vernadsky (1863-1945), Vladimir A. Obruchev (1863-1956), Vladimir V. Tikhomirov (1915-1994).

Philosophy and history of science as the global phenomena were among priorities for Vernadsky. He concluded that a historian of science should know philosophy, history, politics, economy, any science, and its history and methodology. Collecting, analyzing and exchanging of information, a historian of science presents the results as bibliographies, monographs on the history of concepts, scientific biographies etc. Vernadsky initiated foundation of the Commission on the History of Science (1921) working with the Russian scientific heritage.

After the October revolt 1917 geology of the new state was aimed at quick practical effect, and another approach to the history of geology was in demand. Obruchev has demonstrated it with the multi-volume monograph ‘History of the Geological Study of Siberia’ (1931-1949) published as the reviewed bibliography with short biographies of explorers.

The Soviet Union was in political, economic and scientific isolation. The government has strongly influenced the scientific society with bureaucracy and ideology creating *‘The Soviet sciences’* with historical myths and falsifications. Theoretical and methodological principles of scientific work have been weakened.

But the Soviet system could organize studies on the history of geology. The compilation of Obruchev was taken as the model for the great academician project – the ‘Commission of the History of Geological Study of the USSR’ (1955). Academic, educational, and prospecting resources have been concentrated to publish 1050 books of reviewed bibliographies for the whole territory of the USSR (1961-1992).

Tikhomirov headed the Commission since 1956. The number of historians of geology increased, and international relations have been strengthening. To make great progress Tikhomirov renewed the idea of Vernadsky and put compilation of the ‘World History of Geology’ as the main goal of the new project. The Soviet initiative to establish the International Commission on the History of Geological Sciences(INHIGEO) was supported by all Soviet authorities, International Geological Union and International Union of the History and Philosophy of Science.

INHIGEO was founded in 1967 in Yerevan, and 38 Russians were elected its members for 50 years. Their activities and publications on the history of geology (concepts

& methods, development of geosciences, biographies of Russian and foreign scholars etc.) are well known in Russia and abroad,

Science in Russia is under the reform now and managed by the government. The gap among science, education and practical geology is widening, and the history of geology is ‘a privilege’ of enthusiasts but lone persons.

Meanwhile the scientific geological heritage is the Russian treasure, and our mission is to keep it and clean from any misrepresentations for the next generations. It’s possible only with such new ‘world power’ as information technologies.

EVOLUTION OF GEOLOGICAL MAP OF POLAND IN THE 19th CENTURY

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The history of modern geological mapping in Poland began with the *Carta Geologica totius Poloniae, Moldaviae, Transylvaniae, Hungariae et Valachiae*by S. Staszic. Before Staszic, a general map of Poland had been published by Guettard (1764); ones of the Sudety Mts by Jirasek (1791), von Buch (1797), and Raumer (1813); and that of the Tatras by Hacquet (1796). In times of the partition of Poland (1772 to 1918), areas annexed by Prussia were covered by systematic geological surveys. In the period 1826-1836 two atlases were compiled by teams under the leadership of L. von Buch and F. Hoffmann. Another outstanding contribution to the geology of Poland was made by G.G. Pusch, the author of the *Geognostyscher Atlas von Polen*. One of the greatest achievements of L. Zejszner was the geological map of the Tarta Mts, *Carte de la chaine du Tatra,* published in Berlin in 1844. Special attention should be also paid to two extensive studies which covered areas of Upper and Lower Silesia. The first of these, *Geognostische Karte von und den Angrenzenden Oberschlesien Gebieten,* was completed by a team led by F. Roemer (1870). The second, *Geologische Karte von dem Niederschlesischen Gebirge und den angrezenden gegenden,* was compiled by a team led by R. Von Carnall (1867). Out of all the studies carried out by Austrian geologists, it is necessary to mention those of E. Tietze, as they produced excellent geological maps of the Carpathians and vicinities of Cracow and Lviv. It is also worth mentioning the contributions made by the Physiographic Commission. Its members decided to prepare the *Geological Atlas of Galicia*. The final product of works was a set of 25 booklets, with over a hundred geological maps at a scale 1:75000, issued in the years 1885-1912. From 1881, the commission was also publishing its famous *Physiographic Diaries*, which include papers on the geology of Poland, written by famous Polish geologists such as Siemiradzki, Michalski and Habdank-Dunikowski, illustrated with relevant geological maps prepared by them.

THE LOCALIZATION OF MODERN GEOLOGY IN CHINA: A CASE STUDY OF CHINESE GEOLOGICAL JOURNALS (1919 TO 1948)

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Modern geology was introduced into China in the early twentieth century. These theories were to be accepted by the Chinese people after the localization processes of rooting, germination, and growth in new environments. Academic communication is an important part of scientific research. Therefore, as crucial platforms for academic exchanges, as well as the main carriers of scientific research, periodicals have been enriched and perfected with the development of modern geology in China.

Academic periodicals were the main information carriers, and were also the medium of communication for scientific research achievements. The evolution of these periodicals reflected the processes of scientific localization from indirect perspectives. In this study, the geological journals published between 1919 and 1949 were analyzed, in order to discuss the rooting, development, and evolution processes in China following the introduction of Western geology.

GEOLOGICAL MAP OF THE KERCH AND TAMAN PENINSULAS (1851) – INTERESTING MAP DEVELOPED BY HERMANN ABICH (1806-1886)

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Otto Wilhelm Hermann Abich (1806-1886) is known primarily as a volcanologist and geology researcher of Caucasus. He is considered as to be the father of Caucasian geology. Since 1842 he was the professor of mineralogy and geology at the University of Dorpat (now Tartu in Latvia), and he was delegated to carry out the research work in the Caucasus, but also studied other regions of the Russian Empire. He studied, among others, The Kerch and Taman Peninsulas, and the results of these investigations he presented in the work *Einleitende Grundzuge der Geologie der HalbinselnKertsch und Taman* (1865). Probably with this work is related *Geological map of the Kerch and Taman Peninsulas(original title: Geologische Karte der Halbinseln von Kertsch und Taman)*, designed and drawn in 1851.This map is large in size: 975x725 mm. This is a lithography made in Berlin by C. von Birk. The scale of the map (marked only linear) is defined in versts, is approximately 1: 213 400. Longitude is counted from the meridian of Ferro.

The explanations include 9 stratigraphic - lithological units. In some cases the names of the fossils found in the rock formation are listed in the description. On the map are marked also localizations of the emanations of combustible hydrocarbon, occurrences of viscous liquid and naphtha as well as names of antique localities. The morphology of the terrain is shown by the shading and the bathymetry using quasi-isobatcontours. Noteworthy realistic course of the river network. The title of the map is designed in the style of other maps published by the German publishing houses at the time. Some surprise may be the use of the term "GeologischeKarte .." because, by the late 1860s, German geologists used the term "GeognostischeKarte ...".

In conclusion, it is quite decorative map, developed in a typical way for the mid-nineteenth century. Analysis of historical materials shows that it may be one of the oldest (if not the first) geological maps of the region.

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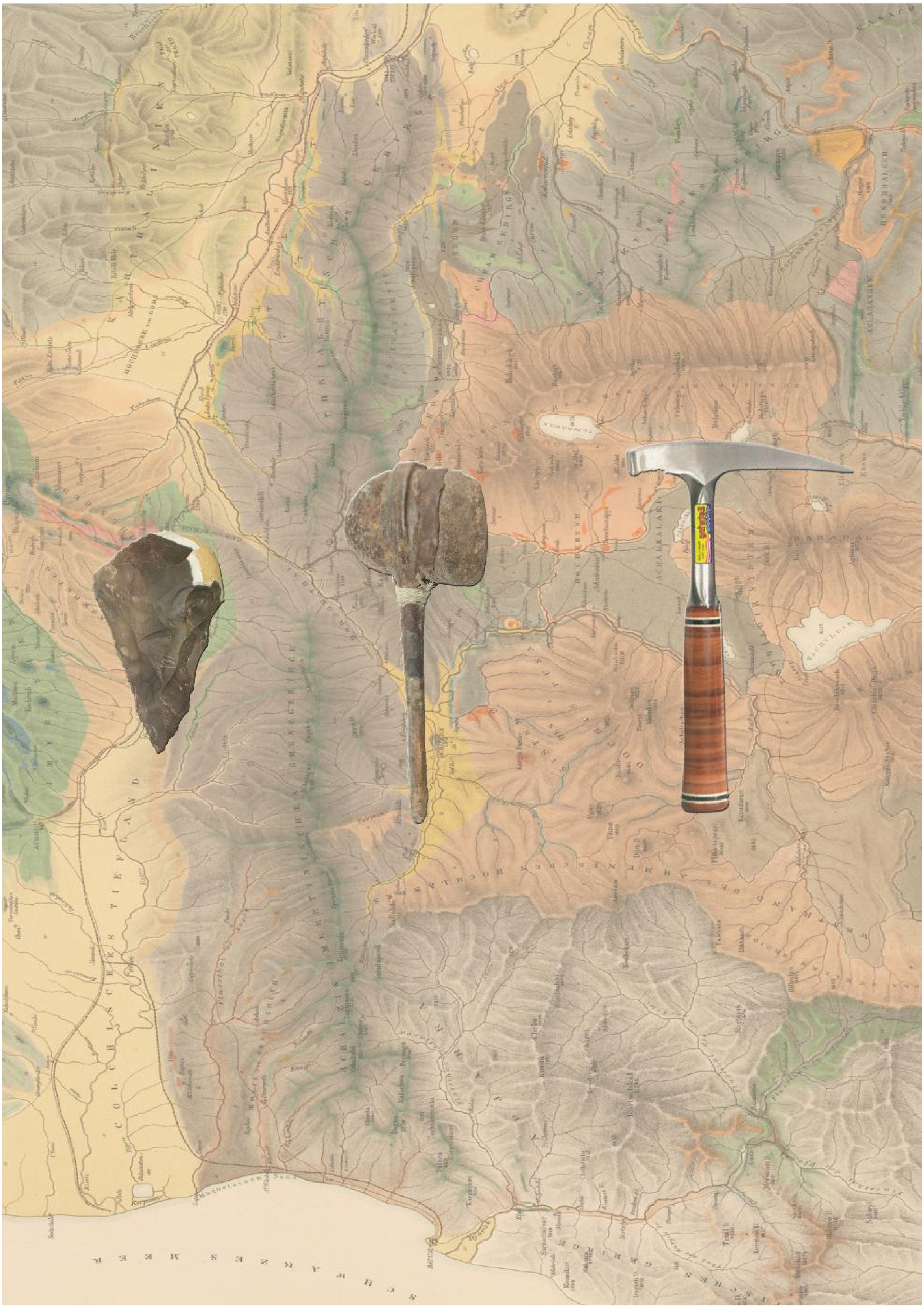
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