1. TITLE, REFERENCE NUMBER. ELABORATION AND QUANTIFICATION OF METALLOGENIC EVOLUTION OF ALPINE FOLD SYSTEM: THE PONTIDES-LESSER CAUCASUS SECTOR OF THE TETHYAN EURASIAN METALLOGENIC BELT.
Reference Number INTAS/GEORGIA-97-1416
Project undertaken April 1999-May 2001
Coordinator: Dr. C. Moon, Geology Dept, University of Leicester, Leicester LEI 7RH, UK; phone +44-116-2523804;fax +44-116-2523918;e-mail cjm@le.ac.uk.

Summary

Cursory examination of the metallogenic maps of Europe shows that the eastern Pontide metallocotect (north of the North Anatolian Fault) is an extension of the Balkan belt and extends into the Transcaucasian republics, notably Georgia. However, comparison of deposits between the Georgian (Georgia) and Turkish (E Pontides) sectors of the Pontide belt has been difficult in the past because of political as well as language difficulties and published detailed comparisons are lacking.
This project examined the correlation on a number of scales. Firstly the geology and controls of mineralization in the major Bolnisi district in Georgia were examined, coupled with a detailed study of the producing Madneuli deposit. This district was contrasted with that of Merisi in north western Georgia. The metallogeny of the Caucasus was examined as was the correlation between the Georgian and Turkish sectors of the Pontides.

Madneuli
Mapping of the open pit and surrounding area at a scale of 1: 2000 suggested that the deposit is an example of the VMS-epithermal transition. The deposit is associated with a volcanic dome and was probably deposited in shallow (<200 m) water depth. The re-mapping has disclosed breccia-conglomerate beds indicating reworking of material from a central pipe. This shallow water origin is consistent with the overall stockwork nature of the deposit topped by small veins and lenses of polymetallic ores and barite.
Mineralogical examination shows a gradation from the quartz-chlorite-pyrite-chalcopyite of the stockwork up to polymetallic sphalerite galena and barite. Homogenization temperatures are ~340°C for the stockwork zone, 200° for the polymetallic ores and 130-200° for the barite zone. The gold zone gives a much hotter temperature of 270-390° associated with cross cutting chalcedony veins, confirming the field observation that the siliceous associated gold mineralization is a late overprint on an already gold enriched deposit.

Bolnisi District
Compilation of data on the Bolnisi district at 1:50 000 showed that the other major types of deposit in the area are generally similar to Madneuli i.e stockwork Cu with barite polymetallic lenses, and possible epithermal gold overprints. There are also a lesser number of gold only shows, such as Sakdrisi. In addition there are a number of iron and minor mercury deposits in the area.
The most significant deposits appear related to lower Santonian calderas (K/Ar: 86-89 Ma) but formed before cauldron subsidence. A later phase of volcanism (65-75 Ma) was superimposed on this. Petrochemical studies demonstrate that the volcanics are calc-alkaline to sub-alkaline in origin.
Detailed mineralogical and fluid inclusion studies of the Sakdrisi gold occurrence demonstrate that the gold is associated with muscovite, biotite, siderite and magnesian chlorite and formed at temperatures of 180-220°.

**Merisi District, Adjara**
The Merisi district is very different from Bolnisi and is hosted in Eocene volcanics and sediments. The major occurrences, such as Varasa and Vaio, are base metals veins that are probably related to alkalic porphyry intrusion. Mineralogically the veins consist of quartz-pyrite, quartz-chalcopyrite-sphalerite and late galena with calcite and barite. Although the base metal potential area is relatively low, gold concentrations have been identified in some veins and alteration zones. Homogenisation temperatures vary from 250-300° in the quartz-pyrite stage through 155-260° in the main polymetallic stage to 60° in the late barite zone. The gold is deposited relatively early in the sequence in the chalcopyrite-sphalerite zone. A petrogenetic investigation revealed an early stage of trachy-dacitic and trachy-andesitic volcanism followed by later trachy-basalts and basalts. The early phase was accompanied by granosyenites and syenite intrusives, contrasting to a later monzonitic stage. Trace element signatures suggest an upper crustal origin for the volcanism.

**Caucasus Metallogeny**
The trans-Caucasian republics can be divided into a number of lithogeodynamic zones, which are characterised by distinct geological histories and metallogenic characters. One area investigated outside the Pontides was the southern slope of the main Caucasus range. Here vein gold deposits are associated with black shales, and the deposits formed from metamorphic fluids derived from flyschoid sediments. Volcanogenic base metal deposits appear to form in volcanic depressions during both subduction and plate collision. Potential areas for further exploration can be mapped out from the metallogenic map generated. Porphyry deposits are found in syenite-monzonite-granodiorite massifs and their location can also be established from the map. It is suggested that areas with potential for skarn formation can be located from environments where chloride brines have developed in equilibrium with hematite bearing volcanic sediments.

**Turkish-Georgian Comparison of Pontides**
Correlation between Georgia and Turkey using GIS technology highlights the similarities between the districts. Although the exact relationship between the Bolnisi area and the eastern Pontides is still not clear the upper Cretaceous VMS deposits are similar with deposits of a stockwork style predominant, e.g. Murgul in Turkey. Gold overprints are a feature both in eastern Turkey and Georgia. Although the exact age remains to be resolved, they appear to be a fundamental feature of the deposit type and not a coincidence. Further west in Turkey the Kuroko-style predominates with massive Zn-Cu ores, e.g. Çayeli and Lahanos, probably deposited in deeper water. The Eocene volcanism is more alkaline and associated with porphyries in both Turkey and Georgia. In Turkey the more significant deposits are epithermal Au and base metal deposits, such as Mastra. Their occurrence in Turkey encourages a search for similar deposits in Georgia. A variety of styles of porphyry deposit are present. These vary from calc-alkaline base metal deposits of upper Cretaceous age in Turkey to more alkaline Eocene deposits that are Au rich both in Georgia and Turkey. The most significant porphyries in the region are late and to the south, in southern Armenia.
Outputs and Applications

Major outputs of the project are maps in Arc view format available on CD from the coordinator. These are 1) Metallogenic Map of the Caucasus; 2) map of the Turkish and Georgian sectors of the Pontides; 3) map of the Merisi Area of Adjara; 4) map of the Bolnisi district and 5) map of Madneuli. These can be applied to highlight new areas for exploration using the references below. Data collected are currently being applied in Bolnisi and Adjara.


Updates will be placed at http://www.le.ac.uk/geology/staff/cjm.html
1. Research

1.1 Scientific Objectives

The project's objectives are as follows:

- To investigate the structure, mineralogy and geochemistry and conditions of formation of some of the more important, and representative, mineral deposits in both the Turkish and Georgian parts of the belt.
- To establish the conditions, timing and chemistry of the hydrothermal systems that formed the deposit.
- To establish the regional structural and paleogeographical factors controlling the distribution of volcanism, plutonism and mineralization.
- To elaborate the reconstruction of the metallogenic evolution of the regions of the East Pontic metalloTECT, NE Turkey and its prolongation in the Lesser Caucasus using GIS techniques.
- To predict areas with a high probability of undiscovered deposits and recommend effective methods for their exploration.

Tasks: Georgian Academy (Academy: Asatashvili (A), Gotsiridze (Go), Gugushvili (G), M. Kekelia (M.K.), Migineishvili (M), Otkhmezuri (O)): Caucasian Institute of Mineral resources (CIMR); University of Leicester (Leicester); Free University of Berlin/Isparta (Berlin)

1. Field study of the structure of formation of significant and representative deposits: largely Academy (M) with help from CIMR, some input from Leicester and Isparta
2. Mineralogical and geochemical study of samples collected: Academy (G, M.K., O) with help from Berlin and Leicester
3. Petrological study of Bolnisi and Merisi: Academy (G, M.K.)
4. Processing of remote sensing data and input to GIS: Academy (A, Go) and CEVIR significant input from Leicester
5. Compilation of GIS: Academy (A, Go) and Leicester.

Research has been more or less in accordance with the work programme. Prof. Ozgiir's illness slowed input from Berlin to mineralogy.

The majority of these were undertaken in Tbilisi. The Leicester and Berlin (Isparta) participants provided computing, sample preparation and logistical support.

See details in Appendix A.

1.2. Scientific Results

The chief results of R.Migineishvili's scientific work are following: 1) compilation of the new version of structural-lithological map of the Madneuli deposit and geological sections to it (1:2000). This map more accurately indicates the stratigraphic position of all host rocks; morphology of bedding, fault and igneous structures; space relations between them, than previous maps. 2) Creation of the new model of formation for Madneuli deposit. The model emphasized the spatial and temporal relationships between volcanic, synvolcanic intrusive, non-ore and ore hydrothermal, sedimentational and deformational processes. Penecontemporary features of these processes are recognized. The Madneuli deposit is identified as a good example of VMS-epithermal transition. 3) Compilation of the structural-lithological map of the Merisi ore field (1:25000) together with S.Kekelia. See the maps, sections and relevant papers in the annex.

Gugushvili's results. 1) He carried out paleovolcanological reconstructions in the Cretaceous volcanic suite of the Bolnisi ore district to determine the paleovolcanic centres, ridges and cauldron subsidences. The following two stages of cauldron subsidences have
been established: Lower Santonian (potassium-argon age 86-89 Ma) and Upper Santonian (65-75 Ma). The most significant deposits of the ore district (Madneuli and Tsiteli-Sopeli) are related to the Lower Santonian calderas and were originated before the cauldron subsidence. As a result of field works the 1:50 000 scale map of paleovolcanological reconstruction has been compiled (Digitized version of the Bolnisi map includes these materials). 2) In the process of investigation of host rock alteration in the Bolnisi ore district, different types of hydromica, carbonate and chlorite were determined. 3) A fluid inclusion study shows, that the most favorable temperature for gold precipitation in Bolnisi ore district is 180-220°C. Gold-bearing quartz-chalcedony veins with gold contents above 2 ppm were accompanied with hydromuscovite, hydrobiotite, siderite and magnesial chlorite alternation. 4) He carried (in close cooperation with Maren Kekelia) petrochemical and geochemical investigations discussed in the M.Kekelia' section. A number of articles resulted directly from these investigations are enclosed in the annex.

**Maren Kekelia's results:**

1) There have been obtained the data on the silicate analyses and REE composition for the magmatic rocks of the Bolnisi Ore District (see table and text in the Annex). The rocks investigated belong to the formations of normal (ryholites, ignimbrites and dacites) and sub-alkaline (basalts, andesite-basalts) series. The rhyolites, ignimbrites and dacites are characterized by varying contents of REE; large-ion lithophilic element (LILE) - K, Rb, Ba, Sr; some high-field strength elements (HFSE) - Zr, Y; and, also, by different values of Eu-anomalies and the degree of fractionating of REE. This may indicate the different deep sources of their genesis. The distribution of Rb, Nb and Y in the rhyolites reveals the possible participation of depleted (ORG) and interplate (WPG) sources in their genesis. The basalts and andesite-basalts are characterized by high values of REE content as compared with N- and E-MORB; the distribution of REE has a differentiated character with enrichment in elements of cerium group - LaN/SmN=2.5-2.7, LaN/YbN=7.5-7.6in basalts and LaN/SmN=3.3-4.1, LaN/YbN=12.7-13.6 in andesite-basalts. These probably indicate proximity to intraplate formations. The participation of intraplate component in their genesis is also confirmed, according to Sun S.S. and Me Donough W.F. (1989), by values of K/La and LaN/YbN which are equal to ~ 500 and -7.5 in the basalts, and ~ 700 and ~ 14 in the andesite-basalts respectively.

2) Mapping of the central part of the Merisi ore field revealed, that: at an early stage of volcanism trachydacite-trachyandesites prevailed. Later, after some breakpoint, they are followed by trachyandesite-basalts and basalts. Here there is comagmatic intrusion of granosyenites and syenites (early stage), as well as monzonites (later stage). The early stage of magmatism is characterized by alkaline content. Some manifestations of alkaline magmatism are also known in the later stage in the form of nordmarkites. One should note, that ore mineralization at the Vaio occurrence is paragenetically associated with syenite- and granosyenite-porphry bodies of the later stage. The mineralization of the Varasa occurrence (polymetallic, copper, gold) is associated with trachydacite-trachyandesites of the later stage of magmatism. This fact presumably indicates the different depths of formation of magmatic bodies. 3) Character of REE distribution suggests that during formation of syenite-diorites, gabbro-monzonites and granodiorites a fractionation of plagioclase occurred (Eu-minimum is apparent). Content of REE, U, Th, Rb/Sr of alkaline gabbro, gabbro-monzonites and gabbro-syenites suggest their origin from upper crust.
Zurab Otkhmezuri's results. On the deposits of Bolnisi ore district the following stages are determined: 1. Quartz-pyrite 2. Copper-sulfide, 3. Barite-polymetallic and 4. Gold-raremetallic. They are separated by the tectonic shifts, shown by breccia and cross textures. In each stage of mineralization by mineral composition and age relations one or several groups of jointly formed mineral complexes can be distinguished. These mineral parageneses are: quartz-pyrite, pyrite-chalcopyrite, sphalerite-chalcopyrite, massive-polymetallic, quartz-barite and quartz-native gold-rare metals. The ore formation of Merisi ore field proceeded in three stages: 1. quartz-pyrite, 2. main sulfide, and 3. late sulfide (with barite) stages. Accordingly quartz-pyrite, quartz-chalcopyrite-sphalerite, quartz-chalcopyrite-sphalerite-galena, quartz-pyrite-calcite and galena-calcite-barite parageneses are distinguished. As it is known, the main criteria for reveal the sequence of minerals and mineral aggregates are textural-structural criteria. The description of structure of ores, the characters of individual mineral parageneses are given in the Annex.

G.Gotsiridze work is the first example of application of GIS in geological investigations in Georgia. He compiled in GIS format the following maps: metallogenic map of the Caucasus (1:500 000), metallogenic map of the Pontides, Structural-lithological map of the Merisi ore field (1:25 000); Geological map of the Bolnisi ore district (1:50 000), Structural-lithological map of the Madneuli deposit (1:2 000).

Sergo Kekelia's results. The example of the Eastern Pontides and the Caucasus indicates that the reconstruction of the past geodynamic regimes of fold-mountain belts can be realized by distinguishing the lithogeodynamic complexes - geological fragments emerging and dying out at various stages of the evolution of regions (pre-collisional, collisional, post-collisional). In certain geodynamic conditions (see the papers), the composite parts of the complexes (geological formations) acquire, as a result of the overall action of magmatic and surficial processes, the metallogenic specialization. The Pontides, developed from Middle Jurassic up to Santonian as an island-arc, consists of 12 lithogeodynamic complexes, and the Caucasus 19 complexes (formed in different geodynamic regimes, see the maps in the Annex). The maps are of practical use as well - each complex (or more precisely, its constituent parts -geological formations) is specialized in one, two or three types of ore deposits. In accordance with the main tasks of the work programme, special attention has been paid to the metallogenic peculiarities of the Pontian-Transcaucasian microplate that represented a composite part of the active paleomargin of the Eurasian continent. Its metallogenic features are characterized by the presence of copper- (VMS) and copper-molybdenum (porphyry), skarn iron-ore, volcanogenic and sedimentary manganese deposits. Their hydrothermal systems are interrelated with the processes on the boundaries of convergently and divergently interacting microplates. For instance, large copper-molybdenum deposits formed in the post-collisional stage of the Alpine cycle in connection with the generation of syenite-monzonite-granodiorite massifs along the border between the North Iranian and Transcaucasian plates. The essential condition of their formation is the presence of porphyry magmatism. It has been established that their fluid systems were dominated by magmatic sources of ore material. The conclusion has also been drawn that skarn iron-ore regimes can originate under the intrusion of magmatic rocks into geological environment in which, prior to its skarnation, the chloride brines were, for a long time, in equilibrium with hematite-containing volcano-sedimentary sequences.
Volcanogenic deposits of non-ferrous metals form at the divergent stage in rifts, and at the convergent (subduction) and collisional stages in volcanic depressions superimposed on deep-seated transversal structures (most likely, of transform nature). Despite the different methods of ore-accumulation (hydrothermal-sedimentary and epigenetic), ores of similar type possess analogous mineral zonality patterns, reflecting the standard composition of hydrothermal fluids, PT- conditions and hydrochemical conditions of ore-accumulation.

It has been considered a problem of gold-potentiality of carboniferous sequences (high potentiality of finding gold-bearing deposits) reveal sequences of the Southern slope of the Greater Caucasus deposited in marginal sea conditions. A genetic model is proposed: first, weathering of ultrabasics and gold segregation, and then, its transportation by streams to the continental slopes, concentration in flyschoid sediments, metamorphic alteration of the latter and their fluidal-magmatic replacement. Finally, the fluidal-magmatic systems moved to hypabyssal levels: first, at subductional, and later- at collisional stages.

As for the large manganese deposits (such as Chiatura in Georgia), we share the opinion by Stoljarov who proposed that manganese-ore accumulation resulted from the interaction of manganese-bearing sulphate-rich fluids (generated in deep-marine hollows) with near-shore oxygen-containing waters.

In conclusion, it should be noted that the functioning of fluid-magmatic systems within the active continental paleomargins was limited, in the author's opinion, by zones of influence of conservative transform structures were favorite pre-conditions were created for: magmatic differentiation of under-crust material (gold-bearing deposits); fluidal-magmatic replacement of metasedimentary rocks (gold-bearing deposits); transformation of sea- and meteoric waters under the action of intrusions (non-ferrous metals deposits); formation of multi-phase hypabyssal intrusions (porphyry deposits); formation of hydro systems in residual deep-marine hollows of marginal seas and their development in the conditions of tectonic instability (manganese deposit).

REFERENCES OF PAPERS:
Gugushvili V., Moon Ch., Ozgur N. (in preparation) Sulfide ore formation and volcanism of theactive margins, island arcs and paleovolcanic activity area of the Caucasus and Turkey.


Gugushvili V., Kekelia M. (accepted for 4-th international symposium on Eastern Mediterranean geology, Isparta, Turkey, 21-25 May, 20001) Geochemical indicators of the geodynamic situation of the Late Cretaceous volcanism and sulfide ore formation in the Artvin-Bolnisi zone (south-west Georgia).


2.4. Applications
The mapping in the Madnelui, Bolnisi, Adjara and Turkish Pontides have been discussed with interested parties and advertised. They have highlighted areas for further work which will be undertaken if government policies are favorable for investment.

In the Caucasus, some areas with a high probability of occurrence of new undiscovered deposits were identified. This theme is discussed in the Explanatory notes of the Metallogenic map of Caucasus enclosed in the Annex. The metallogenic map has been distributed (price US$10) to a number of interested parties including several major international mining companies. The project has helped rekindle interest in the geology of mineral deposits in Georgia.

2. MANAGEMENT

2.1. Meetings and visits

We had two major joint field trips: 1. In Bolnisi district (Georgia) in September 1999 and 2. In Pontides (Turkey) and Achara (Georgia) in July 2000. C. Moon, N. Ozgur, R. Migneishvili, S. Kekelia, M. Kekelia, V. Gugushvili, Z. Otkhmezuri took part in both field trips. Besides that Georgian participants carried out field work for detailed investigations.

In addition C. Moon made 2 visits to Georgia to co-ordinate the project April 1999, April 2001. Georgian participants also visited Turkey in May 2001.

<table>
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</tr>
<tr>
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<td>5</td>
<td>50</td>
</tr>
<tr>
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2.2. Collaboration

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<tr>
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<tr>
<td>East⇔East</td>
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</tr>
</tbody>
</table>

2.3. Time schedule
The schedule had to adapted to the lack of finance.

2.4. Problems encountered
Without doubt the limiting factor on the project was the inability of the Georgian government to deliver finance on time. This caused many setbacks and was not good for overall morale. Infrastructure was a problem in Tbilisi, in particular the lack of electricity.

<table>
<thead>
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</tr>
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<td>X</td>
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</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2.5. Action required
The final installment (10%) of finance will pay western contributors. The Georgian partners have received their contribution, notably a double payment in the last installment of Euros 4000. Money outstanding is 4140, 2000 to Leicester, 2000 to Berlin and 140 to Georgia, plus 1210 still in the account for Academy and CIMR.

2.6. Manpower invested
Overall ~ 7 man years.

3. FINANCE

<table>
<thead>
<tr>
<th>Participant</th>
<th>Name of Participant</th>
<th>Labor Costs</th>
<th>Overheads</th>
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<th>Equipment</th>
<th>Consumables</th>
<th>Other Costs</th>
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</table>
- Has the spending been in accordance with the one foreseen in the Work Programme? If not, in what respect and why? Yes in general. Major item not envisaged was $1000 for car for Academy so equipment costs are higher. More on consumables and less outside work.
- Briefly explain expenditures on equipment, consumables and other costs. Equipment bought were computers and second hand car. Consumables were for chemical analyses and computing consumables. Other costs for outside contract (analyses, some computing).

3.2 Other funding
No other substantial funding was received for the project although both the Universities of Leicester and Isparta provided support in kind (analyses, accommodation and minibus)

4. ROLE AND IMPACT OF INTAS

![Table]

<table>
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<th>rather yes</th>
<th>rather not</th>
<th>definitely not</th>
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<tr>
<td>Would the project have been started without funding by INTAS?</td>
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</tr>
<tr>
<td>Would the project have been carried out without funding from INTAS?</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

- From your point of view, what were the most important achievements of the project? Please tick the adequate boxes in the table below.

![Table]

<table>
<thead>
<tr>
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<th>quite important</th>
<th>less important</th>
<th>not important</th>
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<tbody>
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<td>other (specify):</td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

Will the project continue? No but a similar project has been proposed in collaboration with Armenian workers.

Will the co-operation among the project Contractors continue in the future? Yes, at least in finalizing the results of the project and hopefully in Armenia

5. RECOMMENDATIONS TO INTAS

What was particularly good and should not be changed?
The overall arrangement and aims are good. Staff in Brussels were very helpful.
What was particularly bad and should be changed? Please specify and explain how it could be improved?
A means of submitting payment requests by e-mail would be useful, as postal service is not always perfect. The delays in payment, not of INTAS's making, caused major problems, particularly to morale.
Appendix A. Details of the Work Programme

R. Migineishvili carried out a total re-mapping of the Madneuli deposit open pit. He investigated about 400 thin-sections to identify the petrographic composition of rocks. On the basis of these materials a structural-lithological map of the Madneuli deposit at a scale of 1:2000, as well as 4 geological sections, were compiled. In order drawing of the sections 20 years old mapping of the deposit was also used. He was also involved in the final stages of digitizing procedures of the Madneuli map and the geological map of the Bolnisi Ore District, as well as of geological sections to them, in close association with G. Gotsiridze and M. Asatashvili. He took part in field trips in Georgia and Turkey-Georgia (Merisi ore field) together the other participants of the project (C. Moon, N. Ozgur, S. Kekelia, M. Kekelia, V. Gugushvili, Z. Otkhmezuri). In Turkey we visited the following deposits: Kiire, Lahanos, Cayeli and Murgul and in Georgia Vaio and Varasa ore occurrences. Besides that, during the trip, we had scientific meetings with our colleagues from Isparta university, MTA (Ankara), Trabzon University, Geological department of Achara (Georgia), as well as with geologists from mining companies operating at the noted deposits. This visit was also important in terms of discussion of the project, as well as in terms of coordination of future investigations. R. Migineishvili and S. Kekelia also compiled new version of the structural-lithological map of Merisi ore field in scale 1:25000.

R. Migineishvili as the Principal Investigator shouldered scientific, administrative and organization works in terms of management of the project in Georgia. This works implies following: organization of scientific meetings, field works and workshops in Georgia; purchase of necessary materials and equipments; financial management concerning the ACD team activity; communication between the Georgian Participants, the Grantors and the Coordinator Doctor Moon; and so on. On the behalf of the Georgian Participants R. Migineishvili would like to note a high level of scientific collaboration with the Coordinator of the project Doctor Moon. His kindly help was also important for timely conducting of geochemical and petrochemical laboratory investigations of collected materials. One should also note a very important role of Prof N. Ozgur in an excellent organization of the field trip in Turkey in 2000. Besides that N. Ozgur rendered the Georgian participants assistance in participation in 4-th International Symposium on Eastern Mediterranean Geology (21-25 May, 2001, Turkey).

V. Gugushvili’s has fulfilled the following works: collection and evaluation data on the geodynamic conditions, volcanic activity and sulfide deposits of the area of the Tethys ocean and its active margin developing from Jurassic up to Paleogene; collection and evaluation data on the Artvin-Bolnisi zone (Cretaceous and Paleogene volcanism and their relation with ore formation process); participation in the field trips Georgia and Turkey-Georgia; performance of 40 x-ray diffraction analyses, as well as 20 determination of gas-liquid inclusion temperature on the samples from Bolnisi ore district, analysis of data of geochemical and petrochemical laboratory works (together with M. Kekelia).

Mar en Kekelia has carried out the following works: collection of data concerning the intrusive bodies of the Bolnisi Ore District; description of 100 thin sections (together with V. Gugushvili); participation in the field trips in Georgia and Turkey-Georgia; compilation of metallogenic map of the Caucasus in 1:500 000 scale; compilation of metallogenic map of the Pontides in 1:500 000 scale (see digitized version in the Annex); collection and preparation of some samples from the Merisi ore field for geochemical analyses (together with V. Gugushvili); analysis of data of geochemical and petrochemical laboratory works (together with V. Gugushvili).
Z. Otkhmezuri’s research activities. To carry out the Task 2 the existing materials on mineralogy, mineral parageneses and ore formation process stages of main copper-sulfide and barite-polymetallic deposits of the Bolnisi ore district and copper-polymetallic deposits of Merisi ore field were generalized by Z. Otkhmezuri. The field work has been conducted with a collection of the ore material in the open pit of the Madneuli deposit together with another participants of the project. During the field trip to Turkey and western Georgia ore samples were also collected. On the basis of investigations of relations between ore and gangue minerals in outcrops, analyses of structures and textures of ores, detailed investigations of mineral intergrowth, taking into account the temperature of homogenization of ore and gangues minerals, the general sequence of mineral crystallization was determined, which is demonstrated by paragenetic diagrams enclosed in the Annex.

G. Gotsiridze's work included following three stages. 1) preparation of the raster bases. For this purpose topographic and thematic maps of relevant scales were scanned and registered by means of MapInfo Professional 5.0 in coordinate system of 1942 Krasovsky, Gauss-Kruger projection. 2) preparation of vector base maps. They were created in point (settlement, mine, elevation), lines (roads, rivers, contours, tectonic breaks etc) and polygons (geological features, mining areas etc) by localized marks. Thematic maps were created with database structure. Thematic information for data base was recorded by classification (codes system). According to this classification each figure reflects proper information given in the map legend. 3) The last stage involved preparation of the map layout for print. Completed map was saved as MapInfo Workspace file. During the second year, the thematic layers of the maps prepared in MapInfo format were transferred into the Arc View 3.2 shape file using MapInfo Universal Translator. All these files were transferred into Longitude/Latitude projection. The project was done from shape files in ArcView- completed thematic map. The following problems should be mentioned: very poor physical condition (mostly old papers) of existing analog maps; lack of unified geodetic ground control points for large scale analog maps; lack of full-time access to a computer. All of above-mentioned problems were solved in working period.

Sergo Kekelia carried out the following investigations: generalization of the materials on the geology and metallogeny of the Caucasus; revealing of the main regularities of the metallogenic evolution of the Caucasus (together with Maren Kekelia); investigation of the problem of evolution of ore-magmatic systems of volcanogenic deposits of non-ferrous metals of the Bolnisi Ore District; compilation of metallogenic map of the Pontides in 1:500000 scale (co-authors C. Moon, N. Ozgur, M. Kekelia) (see in the Annex); compilation of metallogenic map of the Caucasus in the scale 1:500000 (co-author M. Kekelia); compilation of the structural-lithological map of the Merisi ore field (co-author R. Migineishvili) in the scale of 1:25000; compilation of geological map of the Bolnisi ore district (1:50000), took part in field trips in Georgia and Turkey-Georgia.

M. Asatashvili in the whole report period was engaged in following: computer-based processing of the geological data, operative transfer of all information between western and eastern participants by e-mail, collection of relevant information from INTERNET, assistance in preparation of manuscripts of some participants, carrying out some operations in digitizing of relief of the Madneuli open pit, as well as in digitizing of the metallogenic map of the Caucasus. Conducted researches have been in accordance with the Work Program. Moreover, for the final report the digital map of the Bolnisi Ore District has been prepared at a scale 1:50000 instead of a scale 1:200000 as it was stipulated by the Work Program, as well
as digital map of Merisi ore field (Achara) has been compiled at a scale 1:25000 instead of 1:200000. These changes of scale allow participants to provide more detail and comprehensive information.

C. Moon (Leicester): main input was in coordination. Also helped arrange field visit to Turkey for major participants. He coordinated the GIS effort and developed some databases for the Turkish data, involving substantial digitisation. Digital data was translated into other packages and archived. He also arranged for chemical analyses and some sections to be made in the UK. Dr. M Akcay (Trabzon) assisted in the field in Turkey.

N. Ozgur (Berlin/Isparta) main input was in arranging for Turkish excursion. He also undertook petrographic and fluid inclusion studies.