Annual Report* of IGCP Project No. 502

*The information in this report will also be used for publication in 'Geological Correlation' (please feel free to attach any additional information you may consider relevant to the assessment of your project).

IGCP project short title: Global Comparison Of Volcanic-Hosted Massive Sulphide Districts

Duration: 2004 - 2008

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1. Website address(es) related to the project

The website of IGCP-502 uses Lulea University of Technology (LTU), Sweden, as host institution. Access is gained to the website via the home pages of the Institution of Applied Chemistry and Earth Sciences and the Division of Ore Geology and Applied Geophysics (<http://www.htu.se/tdg/>). The website address for the first page of the IGCP-502 site is: <http://www.ltu.se/tdg/avd/kgo/forsk/IGCP>

This website is also linked to the International Geoscience Programmes home page (via Geoscience, Earth Resources).

2. Summary of major past achievements of the project

• The project has built up an active scientific network that includes the majority of the world’s leading scientists in the field of volcanic-associated massive sulphide ore deposits, plus a number of scientists from developing countries and postgraduate students. This network now comprises 174 scientists from 33 countries.

• Increased level of cooperation amongst several government institutions and private mineral resource companies in Turkey, Russia, Namibia, Mexico, Morocco, Canada, Sweden, Spain, Australia and Saudi Arabia. This increased cooperation has been of tangible benefit to all involved, and especially to scientists in the developing countries who actively contribute to the project.

• Discovery of fossil hydrothermal chimneys in a VMS deposit of Cretaceous age in Turkey during an IGCP-502 field workshop in 2004 (manuscript in preparation). This is the first discovery of hydrothermal chimneys in Turkey and one of very few such discoveries in ancient rocks.

• Joint field meeting with IGCP-450 in Namibia and South Africa in 2005, which came to the conclusion that current classification schemes for VMS deposits don’t allow for hybrid-types, and that this has a deleterious effect on current exploration philosophies worldwide. We should consider making a new scheme.

• Increased awareness of the effects of metamorphism, deformation and weathering on massive sulphide deposits, and how these processes affect the economics of mining these ore deposits. Papers on these topics will be included in the planned IGCP-502 special volume (see below).
3. Achievements of the project this year

3.1. List of countries involved in the project (*countries active this year)

IGCP-502 has 174 registered members/participants (see list at section 8 of this report) from the following countries. During 2006 we have attracted 36 new members and increased our coverage to 8 new countries.

| 1) Argentina | 18) Japan* |
| 2 Australia* | 19) Kosovo |
| 3) Canada* | 20) Mexico* |
| 4) China* | 21) Morocco* |
| 5) Cuba | 22) Namibia* |
| 6) Czech Republic | 23) New Zealand* |
| 7) Denmark* | 24) Norway* |
| 8) Equador | 25) Peru* |
| 9) Finland* | 26) Portugal |
| 10) France | 27) Russia* |
| 11) Georgia* | 28) Saudi Arabia* |
| 12) Germany* | 29) Spain* |
| 13) Great Britain* | 30) Sweden* |
| 14) Greenland | 31) Switzerland |
| 15) Hungary* | 32) Turkey* |
| 16) India | 33) Venezuela |
| 17) Ireland* |

3.2. General scientific achievements this year (including societal benefits) *(Meetings are listed under heading 3.3.)*

- In several regional study areas of the IGCP-502 project (see two examples below), we are building evidence that VMS ore deposits show transitions in style and genesis with some other major ore deposit types, such as SEDEX, BIF (exhalative banded iron formation), skarn iron and base metal deposits, and epithermal deposits. These transitions are not well documented in the scientific literature and the existing classification of VMS deposits does not take these transitions into account in a systematic way. Accordingly, our project aims to revise and improve the classification and genetic models for VMS deposits. Furthermore, investigation of the transitions between the major ore deposit types may lead to a better understanding of the fundamental hydrothermal processes that influence this whole group of hydrothermal ore deposits.

- In collaboration with scientists in Namibia (see also section 3.4.5) we are investigating apparent transitional features between VMS (volcanic-hosted massive sulphide) deposits and SEDEX (sedimentary exhalative massive sulphide) deposits in the Rosh Pinah area, Namibia. There is currently very little published data on the possible relationships between these two ore deposit types.
Consequently, this work is of international interest and can also potentially contribute to mineral discoveries and employment in Namibia.

- In the Bergslagen mining district, Sweden, recent research and mineral exploration have revived an old concept that there may be a link between the genesis and location of massive sulphide ore deposits and exhalative and skarn magnetite±hematite iron ore deposits. There is no modern literature on the possible connection between these ore deposits types in the Bergslagen region. The IGCP-502 team in Sweden has applied for, and been granted, a major research project to investigate this connection further (see section 7.2). This new research project is already creating considerable interest from the mining industry and will help stimulate new mineral exploration and employment both in the Bergslagen region and elsewhere.

- Scientists in Japan have made important progress in understanding the link between volcanic arc evolution and the genesis of VMS deposits in the NE Honshu volcanic arc. The VMS deposits are attributed to crustal extension just behind the arc-front and can be linked to a change in rhyolitic magma composition that in turn can be related to a change in the depth of melting in the magma source region. IGCP-502 will run a conference and field workshop in Japan during 2007 in order to discuss these important results and facilitate scientific collaboration on this topic among the national IGCP-502 teams.

3.3. List of meetings with approximate attendance and number of countries

3.3.1. International Mineralogical Association (IMA), Kobe, Japan
Title: General Assembly and Science Meeting of the 19th International Mineralogical Association (IMA): Expansion to Nano, Bio and Planetary sciences
Date: 23-28 July 2006
Place: International Conference Centre, Kobe, Japan

Scope of Meeting and Attendance
The IMA-2006 conference was attended by 975 participants (including accompanied parsons) from 50 countries; 874 papers (oral presentation 488; poster presentation 386) were presented during 6 days. The purpose of the Kobe meeting was to assemble scientists and researchers in the fields of mineralogy, geochemistry, petrology, resource geology and related sciences. Among 37 sessions, IGCP-502 co-convened one session at the conference: "Sea-floor hydrothermal systems: Present and past examples", which was convened by Rodney Allen (Lulea University of Technology), Munetomo Nedachi (Kagoshima Univ.) and Tetsuro Urabe (Univ. of Tokyo) on 24 July. This session included eleven oral and 3 poster presentations and received an audience of 50 scientists. The meeting was an opportunity to exchange ideas and information among land-based geologists and sea-going researchers who are interested in the genesis of VMS deposits.

Achievements and Outcomes of Meeting
- The conference session co-sponsored by IGCP-502 was a place of amalgamation between VMS geologists of the world and marine geologists who have been involved in the research on present-day hydrothermal activity of the sea-floor.
The purpose of the session “Sea-floor hydrothermal systems: Present and past examples” was well achieved. Particularly, questions and discussions were very fruitful and filled the conceptual gap between different disciplines.

- The papers were presented by researchers from four nations. We noticed various participants in the audience but we did not count the number of represented countries. (We identified people from Japan, South Korea, China, Philippine, USA, Sweden, Russia, Finland, Australia, and more).
- Presentation by an invited speaker J. Ishibashi on the chemistry of hydrothermal fluids from sea-floor mineralization along island-arcs near Japan stimulated discussion because fluid chemistry is the key to solving the problem of genesis of VMS mineralization in older rocks. A summary talk on arc-related mineralization by T. Urabe was informative because most of the areas described are new discoveries that are not familiar to foreign scientists.
- On the other hand, presentations on ancient VMS deposits gave important clues on the three-dimensional view of sea-floor hydrothermal circulation systems. Therefore, exchange of information was very exciting and fruitful.
- Scientific publication by the Society of Resource Geology in collaboration with IGCP-502 was discussed.

3.3.2. *International Association on the Genesis of Ore Deposits (IAGOD), Moscow, and IGCP-502 field workshop, Ural Mountains, Russia*

Title: 12th Quadrennial IAGOD symposium: Understanding the Genesis of Ore Deposits to Meet the Demands of the 21st Century.

Date: 14-24 August 2006

Place: Moscow and Central Ural Mountains, Russia

Itinerary: Field workshop in the central Ural Mountains, 14-20 August, followed by scientific session at the IAGOD meeting in Moscow, 21-24 August (see also section 8.2).

Scope of Meeting and Attendance

IGCP-502 co-sponsored the field workshop with IAGOD. The workshop was attended by 17 scientists from 10 countries, including the developing countries Turkey, Peru and Russia (see section 8.2 for details). The workshop started in Ekaterinburg and was conducted at representative mine exposures and outcrops of ores and their volcanic host rocks in order to promote discussion and comparisons between the Ural’s type ore deposits and other VMS mining districts around the world. Six open cut mines that span the range of VMS ore deposit types in the Ural Mountains were visited during the workshop. Lectures and discussion sessions were held most evenings.

At the IAGOD symposium in Moscow, IGCP-502 sponsored a scientific session on 23 August titled: "Session I2, Global comparison of modern and ancient VMS deposits – IGCP-502". This session was convened by Rodney Allen (Lulea University of Technology, Sweden) and N. Bortnikov (Institute of Geology of Ore Deposits, Russia) and contained 12 oral presentations and 4 posters, with authors from 11 countries. This IGCP-502 session attracted an audience of 70 scientists and was one of the best attended sessions at the conference.
Achievements of Meeting

• The conference session sponsored by IGCP-502 contained excellent presentations, was well organised, very well attended and was clearly one of the most successful sessions at the IAGOD conference.
• The IGCP-502 session presented a wide variety of studies from 14 different regions of the world and included studies of both ancient ore deposits and deposits actively forming on the modern sea floor. Thus the session was multi-disciplinary and brought together scientists with different experience, skills and interests.
• The scientific session at IAGOD and the field workshop stimulated an enormous amount of discussion between scientists working on different regions, and also between those scientists working on ancient mining districts and scientists studying the modern sea floor.
• The field workshop provided a good introduction to the VMS deposits of the central Ural Mountains and how these ore deposits compare with those that the participants are familiar with in their own countries.
• Valery Maslennikov and his Russian research group are world-leaders in the study of the physical and chemical processes that occur during formation and subsequent degradation of massive sulphide deposits on the sea floor. These studies are not well documented in the international literature, nor are they well understood by foreign (non-Russian) scientists. Consequently, this workshop was an important opportunity for the IGCP-502 group to discuss these interesting concepts.
• Future meetings and scientific publications of IGCP-502 were discussed.

Outcome of Meeting

• Participants of IGCP-502 gained an appreciation of the complex geology of the Ural Mountains. In particular, the Urals ore deposits are among the best preserved in the world, so this was a rare opportunity to see and understand the primary geometry, internal structure and ore textures of sea floor massive sulphide deposits. This information will be especially valuable for those scientists working on ancient regions elsewhere in the world where the ores are not as well preserved.
• In ancient VMS ore deposits, bornite and covellite are commonly interpreted to be relatively high temperature primary, and low temperature secondary minerals, respectively. The field trip participants saw evidence in the Urals that suggests that bornite, hematite and covellite may also commonly be late-stage, low-temperature, primary to diagenetic minerals that replace earlier-formed higher temperature sulphide mineral assemblages.
• An important outcome of the meeting was also the growing consensus among scientists in the IGCP-502 group that nearly all VMS ore deposits in volcanic arcs occur within the vents of volcanoes, and especially where extensional faults intersect these volcanic centres.
• The scientific session and the field workshop stimulated several new scientific collaborations between participants of IGCP-502 which have lead to proposals for co-authored papers that will be included in the IGCP-502 special issue of Mineralium Deposita journal (planned publication in late 2008, see section 4.1).
• The conference session in Moscow attracted wide interest and IGCP-502 signed up 10 new members.
3.3.3. **XIII Congreso Peruano de Geología, Peru**

IGCP-502 (Fernando Tornos, co-leader) gave an invited presentation titled: “Styles of mineralization in VMS systems” at the 13th Geological Congress, Lima, Peru, October 2006.

3.4. **Educational, training or capacity building activities**

3.4.1. **Field workshops**

This project runs on average two field workshops each year, and also co-sponsors 1-3 scientific meetings each year. All meetings have been highly successful. The field workshops have been particularly popular and have proved to be an excellent way of disseminating experience and skills between scientists from the developed and less developed countries. This year, the field workshop in Russia provided an opportunity for Russian scientists and students to interact with VMS specialists from the IGCP-502 group. Post-graduate students from Peru and Sweden also attended the workshop.

3.4.2. **IGCP-502 Short course on Volcanology and Ore Deposits**

This year (25 April – 3 May) IGCP-502 ran a short course in Turkey for Turkish scientists, students and IGCP-502 members (see section 8.3 for details). The course was funded by Turbitak (Turkish government funding agency), MTA (Geological Survey of Turkey), Istanbul Technical University, Cayeli Mining company and Volcanic Resources Limited). The course was attended by 10 scientists from the Geological Survey of Turkey, 8 post-graduate students and professors from Istanbul Technical University and 8 scientists from Russia, Finland, Sweden, Ireland and Saudi Arabia. The course forms part of an on-going collaboration with MTA and Cayeli Mining Company who are carrying out geological mapping and mineral exploration in the Pontides belt (see section 7.2).

The short course was titled: “Interpretation of Volcanic Rocks in Mineralized Volcanic Terranes” and comprised 3 days of lectures and laboratory exercises (hand specimens and thin sections) at Istanbul Technical University and 4 days field work in the eastern Pontide mineral belt, NE Turkey. The course leader was Dr. Rodney Allen (one of the leaders of IGCP-502).

3.4.3. **Lectures to students at Tohoku and Akita Universities, Japan**

IGCP-502 (Rodney Allen) was invited to Japan for 2 weeks (September-October) by the Centre Of Excellence Program (COE), Tohoku University and Akita University, Japan. The purpose of this invitation was to present lectures to Japanese students and collaborate with Japanese scientists working on the geological setting of VMS ore deposits. The lectures presented were titled: “Volcanism related to kuroko-type massive sulphide deposits: World-wide and Japan”. The lectures were presented under the IGCP logo and were attended by 70 students and professors.

3.4.4. **Post-graduate students**

Several Master of Science and PhD students are studying projects organised by, or affiliated with, IGCP-502. These include students from Peru, Sweden, Spain, Canada and Russia. The project has also provided advice and guidance (PhD topics, research programs) for students from Iran, India and Turkey.
3.4.5. Collaboration and capacity building activities, Namibia

In Namibia we are assisting Namibian scientists (University of Namibia, Geological Survey of Namibia, mine geologists) to understand the physical volcanology, hydrothermal alteration and style of mineralization of the Rosh Pinah mine and surrounding area. An additional aim is help the mine staff learn to recognize key features for mineral exploration in the area. This area has large ore deposits that show transitional features between VMS and SEDEX deposits. The Rosh Pinah deposit is perhaps one of the best examples of this transitional character. It is hosted by Neoproterozoic shale, however, the deposit lies close to contemporaneous felsic volcanic rocks. The work involving IGCP-502 has consisted of interpretation of the volcanic stratigraphy (mainly dacite lava domes), and characterization of the environment of deposition. This work has been led by Fernando Tornos (Spain) in collaboration with Gregor Borg (University of Halle, Germany).

3.4.6. Collaboration, training and capacity building activities, Peru

In Peru, within the framework of IGCP-502, and with funding from the Spanish Geological Survey, we are assisting INGEMMET in the study of massive sulphide ore deposits of Cretaceous age in the Casma Group. This work is being led by Fernando Tornos (co-leader of IGCP-502, Spain). In Peru, there is a rather poor knowledge of VMS ore deposits because most of the “traditional” mineralization in Peru is related with Andean magmatism and includes porphyry copper, epithermal and skarn ore deposits. However, in recent years there have been several discoveries of massive sulphide deposits of probable VMS-type hosted by the Casma Group, which developed in a Cretaceous back arc basin setting. Our objective is to train young staff of the INGEMMET in three fundamental topics: (1) the description of the ore deposits and host rocks, (2) interpretation of structures in the volcanic rocks and (3) the recognition of different styles of mineralization. Training will continue in the coming years through a collaboration agreement and will focus on the development of postgraduate theses and help with interpretation of analytical data.

3.5. Participation of scientists from developing countries

Of the project’s 174 current members, 28 are from the developing countries: Russia, Turkey, Morocco, Namibia, Peru, Mexico, Bulgaria, Cuba, China, Hungary and Kosovo (see list of members and email addresses below in section 8). Furthermore, this number is not a true picture of the participation from developing countries, because in many cases the project has just one or two email contacts with chosen IGCP-502 co-ordinators in these countries. These co-ordinators disseminate information from our project to other scientists in their country. For example, many Turkish scientists have taken part in IGCP-502 field meetings, workshops and courses (about 50 Turkish geologists and post-graduate students). However, the contact people on our mailing list / list of members are two professors at Istanbul University, the chief geologists of the Turkish Geological Survey and the chief exploration geologist at Cayeli Mining company.

Scientists from Turkey, Russia, Morocco, Mexico, Namibia and Peru have been particularly active in the project. We have tried to support these scientists as much as possible via scientific collaboration and financial support to our field workshops.
3.6. List of most important publications in 2006 (including maps) (no abstracts).

3.6.1 Most important peer review literature


Piercey, S.J., Peter, J.M., Mortensen, J.K., Paradis, S., Murphy, D.C., Tucker, T.L., in press, Geological, geochemical and U-Pb age constraints on the origin of footwall porphyritic rhyolites from the Wolverine volcanic-hosted massive sulphide (VMS) deposit, Finlayson Lake District, Yukon, Canada. Economic Geology.


3.6.2 Published books


3.6.3 Other peer-reviewed publications


3.7. Activities involving other IGCP projects or the IUGS

The collaboration and capacity building activities in Namibia described in section 3.4.5 stem from the joint field workshop held by IGCP-450 and IGCP-502 in Namibia and South Africa last year. Collaboration between scientists in these two IGCP projects continues.

4. Activities planned

4.1. General goals

The general goal of IGCP-502 remains the same: to make a major step forward in the understanding of where, when and how VMS deposits form during the evolution of extensional plate margin terranes. We believe that in order to make this step forward it is essential to compare and contrast the geology of several of the world’s major VMS mineral belts/terranes so that the critical common features can be distinguished from the myriad of other probably less important features. To date IGCP-502 has run field workshops in 6 major VMS belts: Iberian Pyrite Belt (Spain and Portugal), Skellefte district (Sweden), Eastern Pontide belt (Turkey), Bathurst district (Canada), southwest Africa (South Africa, Namibia) and the Ural Mountains (Russia). These and planned future workshops (see below) are an important step toward realising the goals of the project. These workshops enable comparisons of the various VMS belts by the ICP-502 group, and also enable transfer of ideas, results and methods / technology between scientists and research groups in the best possible environment – on site in the field and in the laboratory! The workshops are also an excellent way of transferring knowledge to scientists from the developing countries.

It is clear that both individual scientists, and the IGCP-502 group as a whole, have learned a lot from the field workshops and other meetings that we have held. In addition, new scientists and countries are joining the project each year.
During 2006 we have progressed forwards with the two major goals outlined in our 2005 annual report: a detailed scientific questionnaire on VMS districts, and an IGCP-502 Special Issue of the international scientific journal, Mineralium Deposita. The detailed questionnaire has been lodged on the project website (see address above) and all research/national groups participating in IGCP-502 have been asked to download and complete the questionnaire during 2007. The completed questionnaire will provide the project with a detailed new database on the knowledge of VMS deposits and VMS districts throughout the world. The results of the questionnaire will be published on the project website and will also be used for future collaborations and publications. One such publication is the IGCP-502 Special Volume, which is planned to be published by Mineralium Deposita Journal during 2008. During 2006, IGCP-502 project members have submitted their proposals for contributions to this special volume. The project leaders have finalised a list of accepted proposals, and other papers for which we are inviting specific authors to write. This list of proposed papers is provided below:

Title And Theme Of The Special Volume: "Key Issues And Controversies In The Geological Setting And Genesis Of Volcanic-Hosted Massive Sulphide (VMS) Deposits"

Editors: IGCP-502 Project Leaders

Papers / Contents:
1) Introduction To The Special Volume And Synthesis Of Results
2) Tectonic Settings Of VMS Deposits
3) The Timing And Location Of VMS Deposits In The Evolution Of The NE Honshu Volcanic Arc, Japan
4) The Role Of Cauldrons, Calderas And Dome Complexes In The Formation Of VMS Deposits
5) The Relevance Of Recent Studies Of The Modern Ocean Floor To Understanding The Tectonic And Volcanic Setting Of Ancient VMS Deposits
6) Are Modern Seafloor Sulphide Deposits True Analogues To The Ancient Examples?
7) How And Why Do VMS Ores Form By Replacement Of Volcanic Deposits?
8) The Role Of Felsic Magmatism In The Formation Of VMS Deposits
9) The Role Of Mafic Magmatism In The Formation Of VMS Deposits
10) The Role Of Magmatic Fluids And Volatiles In The Formation Of VMS Deposits
11) Basinal Fluids And The Origin Of Massive Sulfides: A Numerical Fluid Flow Study From The Iberian Pyrite Belt
12) The Role Of Water Depth In The Formation Of VMS Deposits
13) A Critical Appraisal Of The Evidence For And Relative Importance Of Plumes, Brine Pools And Mounds In The Formation Of VMS Deposits
14) A Critical Appraisal Of The Role Of Oceanic Anoxia In The Formation Of VMS Deposits
15) Black Shales And Massive Sulphides: Causal Or Casual Relationships
16) Textural And Chemical Evolution Of Clastic Sulphide Textures In VMS Deposits.
17) Post-Depositional Tectonic Modification Of VMS Deposits And Its Economic Significance
18) The Evidence For A Continuum Between VMS Deposits, Sedex And Epithermal Deposits
19) Applicability Of Heat And Fluid Flow Modelling In The Study Of VMS Deposit Formation
20) Supergene Alteration Of VMS Deposits

Each paper in the special volume will provide a summary of the evidence for the proposed hypothesis or interpretation, a comprehensive account of the critical features and how these critical features are recognised, and their interpretation. The deadline for submission of papers will be Autumn 2007, so that the volume can appear by the end of the project, December 2008.

4.2. Specific meetings and field trips (please indicate participation from developing countries)

4.2.1. Dublin SGA Conference and associated field trips, 2007
The next SGA Biannual meeting will be held in Dublin, 20-23 August 2007 and within it there will be a special session (session 16) sponsored by IGCP-502, entitled “seafloor hydrothermal systems”. The session will be devoted to reviewing some of key problems in the study of VMS systems and to present information from new deposits worldwide. There will be field trips to the volcanic-hosted massive sulphides in Wales and Ireland (field trip 7) and the Iberian Pyrite Belt (field trip 5), which are both co-sponsored and organised by IGCP-502. Further information can be found at http://www.conferencepartners.ie/sga2007/

4.2.2. Tokyo and NE Japan: Relationship between VMS (Kuroko) deposits and the Evolution of Volcanic Arcs, 2007
IGCP-502 is organising a 2-day conference and 6-day field workshop to discuss the relationships in time and space between the formation of VMS ore deposits and the evolution of marine volcanic arcs. This will be the major meeting of IGCP-502 in 2007. We will collect together a very multi-disciplinary and multi-national group (35-50 scientists) of field geologists, modern seafloor specialists, igneous petrologists, ore deposit geologists and geochemists, with the aim of learning from each other. We will also use IGCP-UNESCO funds to invite scientists from developing countries. NE Japan is an excellent place to study and discuss the critical issues. Japanese scientists have good knowledge of both the structural and magmatic evolution of the arc-backarc system and have recently made important steps forward in correlating the stratigraphy of the VMS host successions with evolution of the volcanic arc.

Organisers and field trip leaders:
Tetsuro Urabe, Hiroshi Sato (Tokyo University)
Takeyoshi Yoshida, Ryoichi Yamada (Tohoku University, Sendai)
Toshio Mizuta, Daizo Ishiyama (Akita University)
Takeshi Ohguchi (Emeritus professor Akita University)
Rodney Allen (Lulea University, Sweden)

Programme:
26 October: Participants arrive Tokyo.

Day 3 (29 Oct): Akita. Study stratigraphic drill cores showing the host volcanic succession from the Hokuroku Basin kuroko district. Visit the Akita University mining museum, which has a good archive of kuroko specimens. Travel Akita to Oga. Geological stop at Oga before dinner.

Day 4 (30 Oct): Oga Peninsula. Oligocene-Late Miocene type section of the Green Tuff in superb coastal exposures. The kuroko time-stratigraphic interval at Oga is mainly shallow marine, and stratigraphy is somewhat different to the kuroko areas because Oga is on the back-arc side of, and outside of, the main graben basins that contain kuroko ores. The lower part of the Oga stratigraphy provides information about the early development of back-arc rifting.

Day 5 (31 Oct): Oga to Hokuroku (Ohdate) via the Babame kuroko area and/or other exposures of the Neogene volcanic succession and basement. Babame area contains a few small kuroko deposits but the alteration system is well exposed.

Days 6-7 (1-2 Nov Oct): Early-Late Miocene succession of the Hokuroku district: pre-subidence Early Miocene terrestrial andesitic rocks; Middle Miocene lower pillow basalts (Hotakizawa basalt); footwall and hanging-wall rhyolitic domes and pyroclastics; Shijuhtaki basalt fire fountain deposit which directly overlies the ore horizon; visit to old Motoyama open pit.

Day 8 (3 Nov): Hokuroku to Morioka. Late Miocene to recent volcanism of the backbone mountain belt (arc front region). (a) Late Miocene felsic caldera magmatism and hydrothermal systems E/SE of Hokuroku district; these calderas mark the end of kuroko-related volcanism, uplift of the arc, and change to period of major felsic caldera volcanism. (b) Active volcanism and hydrothermal activity at the present arc front at Hachimantai and/or Iwate volcanic areas.

4 Nov (Day 9): Travel home.

4.2.3. 33rd IGC, Oslo, Norway 2008

IGCP-502 plans to make the IGC in Oslo the project’s major meeting for 2008. We have submitted a proposal to the IGC committee for a scientific session: "Volcanic-hosted massive sulphide deposits: controls on distribution and timing at the deposit-, district- and global-scale". This session could take all the IGC contributions concerning volcanic-hosted massive sulphide ore deposits and their geological setting. IGCP-502 has also proposed to run a field workshop to Bergslagen, Sweden, as part of the IGC (see details below). This trip may be the final field workshop for IGCP-502, which will be in it's fifth year in 2008.

Field workshop title and theme: "Paleoproterozoic volcanic- and limestone-hosted massive sulphide deposits in Bergslagen, Sweden: Characteristics and geological setting".

Organisers and field trip leaders:
- Rodney Allen (Lulea University, Sweden)
- Michael Stephens (Geological Survey of Sweden)
- Magnus Ripa (Geological Survey of Sweden)
- Krister Sundblad (University of Turku, Finland)
Other Field Workshops and Meetings
We are considering proposals for additional field meetings during 2008. Possible locations include the developing countries Georgia and Mexico.

5. Project funding requested

Project 502 requests the full annual funding of US$ 6,000 from IGCP. See section 7.2 for a summary of additional funding that has been requested and granted to IGCP-502 from other sources.

6. Request for extension, on-extended-term-status, or intention to propose successor project

This project is currently in its third year. We wish the project to continue the full term of five years. Further on in the project we will be better able to predict the theme and nature of any extension or successor project.

7. Financial statement

7.1 Use of IGCP funds

IGCP-502 received US$ 5,500 dollars from UNESCO-IUGS during 2006. This funding was used completely (100%) to support project members to attend the main field workshop in Russia (see table below). The funds were provided to scientists from Turkey and Russia, and to a very active young scientist from Canada. The travel funds were allocated according to the distance that these scientists needed to travel to the meeting in Russia. Some funds were also used to pay for minivan transport during the field workshop.

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<td>Russia</td>
<td>US$ 1500</td>
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<th>Total</th>
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<td>US$ 5,500</td>
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</table>
7.2 Additional funding obtained from different sources.

**IGCP-502 Short course on Volcanology and Mineral Deposits, Turkey**
Funding from Turbitak (Turkish government funding agency), MTA (Geological Survey of Turkey), Istanbul Technical University, Cayeli Mining company and Volcanic Resources Limited) for the IGCP-502 short course in Turkey, April-May 2006 (see section 3.4.2)
US$ 8,000

**Mineral Exploration for VMS Deposits in Eastern Pontides, Turkey**
The Metallic Minerals Exploration Department of the Mineral Research and Exploration General Directorate (MTA) of Turkey runs a project in the Eastern Pontides region in collaboration with IGCP-502. This project includes 1/10,000 to 1/25,000 scale geological mapping and prospecting for VMS deposits in the Surnen and Artvin areas (2005-2007).
Approximately US$ 50,000 per year

**Collaboration between IGCP-502 and Tohoku University, Japan**
Grant to Takeyoshi Yoshida and Rodney Allen from Japan Centre of Excellence: US$ 4,000

**Subproject of IGCP-502 in Sweden: Bergslagen Research Project**

**Co-sponsorship of IGCP-502 field workshop in Ural Mountains, Russia**
IAGOD (International Association on the Genesis of Ore Deposits) provided funds for organization of the field workshop and publication of the field guide.
Approximately: US$ 5,000

**Minerals and Geoscience Synthesis of the Slave Geological Province, Northern Canada**
This project by the Geological Survey of Canada is affiliated with IGCP-502 and is run by Canadian members of IGCP-502 (Jan Peter, Project leader). The project includes work on VMS districts, including the Hackett River Greenstone Belt and the High Lake Greenstone Belt.
US$ 87,000 per year (2003-2007)

**Magmatism, hydrothermal activity and ore deposits in transpressive orogens: the SW Iberian Peninsula**
This project is one of Spain’s main scientific contributions to IGCP-502. The project (project BTE 2003-0290) is funded by Dirección General de Investigación.
Organizations involved: IGME, University of Bilbao, University of Madrid.
US$ 200,000
Support to Spanish participation in the coordination of IGCP-502
Number of researchers: 4.
US$ 45,000; US$ 8,000 per year.

Support to Swedish participation in the coordination of IGCP-502
Funded by the Research Council of Sweden and the Swedish national IGCP committee; for 2006. Number of researchers: 2.
US$ 7,000

Hydrothermal systems in the Tyrrhenian Sea
A scientific cruise will be conducted to study hydrothermal systems in the Tyrrhenian Sea during August 2006. This project is a German contribution to IGCP-502, is led by Thomas Monecke and Sven Petersen, and consists of two parts:
1) Shallow drilling of hydrothermal systems in the Tyrrhenian Sea using R/V Meteor and BGS Rock-drill. A proposal for the use of R/V Meteor has been granted by the Oceanographic Commission of the German Research Foundation.
2) Fluid sampling of active hydrothermal systems in the Tyrrhenian Sea using R/V Poseidon and ROV Cherokee. A proposal for the use of R/V Poseidon has been granted by the German Research Foundation.
US$ 4,500 plus use of the ships and equipment

8. Other relevant information
8.1. List of participants in IGCP-502 and their email addresses (174 members)
Abdelkhalek Al Ansari <alansari@ucam.ac.ma>, Nasir Al-Jahdli <aljahdli@yahoo.com>, Salah Al-Khibash <khirbash@squ.edu.om>, Francisco Alonso <alonso@uhl.es>, Wiking Andersson <Wiking.Andersson@boliden.com>, Anfilogov <anfilogov@ilmeny.ac.ru>, Peter Appel <pa@geus.DK>, Hans Åreback <hans.areback@lgold.se>, Nick Arndt <Nicholas.Arndt@ujf-grenoble.fr>, Tim Barrett <tjbarrett@bmts.com>, Tucker Barrie <barriect@sympatico.ca>, Abdelhay Belkabir <abelkabir@yahoo.fr>, Kjell Billström <Kjell.Billstrom@nrm.se>, Terje Bjerkgård <terje.bjerkgard@ngu.no>, Arne Bjorlykke <arne.bjorlykke@ngu.no>, Derek Blundell <d.blundell@gl.rbhnc.ac.uk>, Gregor Borg <borg@geologie.unihalle.de>, Nick Burcham <Nikolai.Burcham@eumik.org>, Bernd Buschmann <Bernd.Buschmann@mineral.tu-freiberg.de>, Namik Cagatay <cagatay@itu.edu.tr>, Antoni Camprubi <camprubi@geociencias.unam.mx>, Xiomara Cañazas <xiomara@jgp.minbas.cu>, Carlos Canet <ccanet@tonatiuh.igeofcu.unam.mx>, Joan Carles Melgarejo <joanc@geo.ub.es>, Ray Cas <ray.cas@sci.monash.edu.au>, Ricardo Castroviejo <ricardoc@minas.upm.es>, Carmen Conde <c.conde@igme.es>, Nigel Cook <nigelm@nhm.uio.no>, Louise Corriveau <Louise.Corriveau@nrcan.gc.ca>, Alan Coutts <couttsa@bms.ca>, Tony Crawford <Tony.Crawford@utas.edu.au>, Garry Davidson <Garry.Davidson@utas.edu.au>, Garnet Dawson <gdawson@eurozinc.com>, Teodosio Donaire <donaire@uhl.es>, "Mike Doyle (Cobre las Cruces)" <mdoyle@cobrelascruces.com>, Garth Earls <garth.earls@detini.gov.uk>, Pasi Eilu <pasi.eilu@gtk.fi>, Abderrahim Essaifi <essaifi@ucam.ac.ma>, Craig Feebrey <feebrey@jogmec.go.jp>, Lluis Fontboté <Lluis.Fontbote@terre.unige.ch>, Jim Franklin <jfranklin4@compuserve.com>, Les
8.2. Itinerary and participants of the IGCP-502 field workshop in the Ural Mountains, August 2006

Title of Field trip: Lithogenesis, metamorphism and ore facies of the Middle and Northern Urals VMS deposits

Leaders: Prof. Valery Maslennikov and Dr. Igor Zhukov, Institute of Mineralogy, Urals branch of Russian Academy of Sciences, Miass

13 August: Meeting in Airport Koltsovo. Arriving to the Ekaterinburg hotel “Bolshoy Ural”.
14 August: Ekaterinburg – Serov with a field lunch on the Kabanovskoe VMS deposit damp (Middle Urals). Banded sulphide facies. Geology along the way. Hotel in Serov.
15 August: Serov – Karpinsk (Northern Ural). Active open pit and ore dump at Valentorskoe deposit. Relic lower part of very well preserved small sulphide mound, vent chimneys, clastic sulphide ore facies, Cu-rich ore, bornite seaﬂoor alteration, gossany jasper, subseaﬂoor replacement of hyaloclastite, sulphide stockwork zone. Back to Serov Hotel.

18 August: Ekaterinburg – Rezh (Middle Urals). The Saphyanovskoe VMS deposit open pit. Large sulphide mound, very well preserved hydrothermal colloform sulphide facies, sulphide breccia, sulphide turbidites and their diagenetic products (diagenites), refining zone, tube worms and vent chimney fragments (difficult to find). Rezh-Ekaterinburg. Academician Hotel.

19 August: Superb Geology around Ekaterinburg, geological and mineralogical museums. Academician Hotel

20 August: Ekaterinburg – Moscow.

List of Participants
1. Rodney Allen, Lulea University of Technology, Sweden
2. Alain Chevalier, Chief Geologist Lundin Mining Exploration, Sweden
3. Cornel de Rond, Principal Scientist GNS Science, New Zealand
4. Marcello Imana, Peru, Project Geologist Lundin Mining Exploration
5. Daizo Ishiyama, Akita University, Japan
6. Iskender Kurt, Geological Survey of Turkey (MTA)
7. Jan Peter, Geological Survey of Canada
9. Neil Martin, Jabiru Metals Limited, Australia
10. Toshio Mizuta, Institute of Applied Earth Sciences Akita University, Japan
11. Denis Schlatter, PhD Student Lulea University of Technology, Sweden
12. Steve Scott, University of Toronto, Canada
13. James Walker, New Brunswick Department of Natural Resources, Canada
15. Richard Herrington, Natural History Museum, London, Great Britain
16. George Petrov, Geological Mapping Enterprise, Ekaterinburg, Russia

8.3. Content and Itinerary of the IGCP-502 short course, Turkey, April-May 2006

Course title: "Interpretation of Volcanic Rocks in Mineralized Volcanic Terranes”.

April 25-27 (Tuesday–Thursday): 3 x 2/3 day lectures, 3 x 1/3 day exercises (hand specimens and thin sections of young and ancient volcanic rocks).
April 27 evening or April 28 morning: fly to Trabzon, NE Turkey.
April 28: 1/2 day lectures in Trabzon at MTA (state geological survey and exploration authority), field work in Culköy – Kale Deresi area.
April 29: Field work along the Macka stratigraphic section.
April 30: Field work on the Macka high plateau; Yenimahalle volcanic sequence and VMS-barite deposit.
May 1: Field work at the Kutlular open pit VMS deposit and Cukurköy prospect.
May 2: Drill core logging and interpretation exercise at Cayeli Cu-Zn mine (Inmet Mining). Afternoon/evening: course ends at Cayeli.
May 2 evening/May 3 morning: course participants travel home.

Lectures
Magmas and volcanism: magma ascent, eruption, transport, deposition, reworking of volcanic deposits.
Descriptive and genetic classifications of volcanic rocks
Describing and naming volcanic rocks
Facies concept in sedimentology and volcanology
Importance of rock texture, bedforms and contact relationships
Distinguishing primary versus reworked, and syneruptive versus post-eruptive volcaniclastic deposits
Main volcanic rock types:
   (a) Lava flows and intrusions: subaerial and subaqueous
   (b) Pyroclastic rocks: subaerial and subaqueous
   (c) Other volcaniclastic rocks
Effects of alteration, deformation and metamorphism
Volcano types, proximal to distal facies associations, how to distinguish vent areas