



Research Networking Programmes

Science Meeting – Scientific Report

Proposal Title: Afar Carbonate Research Workshop

Application Reference N°: 5827

AFAR Carbonate Research Workshop

**School of Earth Sciences, Addis Ababa University, Ethiopia
January 20-21, 2015**



Summary

The AFAR Carbonate Research Workshop in Addis Ababa (Ethiopia) was the first strategic and exploratory workshop to (1) trigger and discuss well-defined research initiatives (research projects and future drilling initiatives focusing on the carbonate and evaporitic deposits in the Danakil Depression, Afar, Ethiopia) within the northern Afar, (2) explore the exchange possibilities for scientists and students between Ethiopia and Europe, (3) stimulate direct interaction between Academia and stakeholders of the local Potash Industry.

Description of the scientific content and discussions at the event

Opening Ceremony

The participants of the Workshop are warmly welcomed by Dr. **Jeilu Oumer**, Academic vice President of Addis Ababa University, Ethiopia.



Figure: Dr. Jeilu Oumer (Vice President of Addis Ababa University, Ethiopia) – Mr. Ato Tolossa Shagi (Minister of Mines, Ethiopia) – Prof. Anneleen Foubert (Professor Carbonate Sedimentology, University of Fribourg) – Prof. Seifu Kebede (Head of School of Earth Sciences, Addis Ababa University, Ethiopia)

Mr. **Ato Tolossa Shagi**, Minister of Mines, Ethiopia, emphasizes the importance of research and international collaboration between academia and industry in the development of Ethiopia's natural resources. Ethiopia's growing economy builds upon the supply of domestic raw materials, on strong foreign investment that contributes to employment and economic development, and on export that contributes to foreign exchange earnings. Universities have a role to play in providing adequately trained human resources, well matched with the economical sector's needs.

Prof. **Anneleen Foubert**, Fribourg, introduces the Afar Carbonate Research Consortium, aiming to a basin-wide understanding of the sedimentary facies evolution in an active rift, paced by environmental fluctuations and tectono-magmatic events.

In October-November 2013, the consortium has started with a reconnaissance of the sedimentary units at the Danakil basin margins to understand the geometric distribution and intertwining of marine, hypersaline and lacustrine syn-rift sedimentary deposits. It aims through a detailed mapping to establish a well-constrained stratigraphic framework, supported by radiometric datings. Petrographical, petrophysical, geo-biological and diagenetic studies will help to understand processes of microbial-mediated precipitation in rapidly alternating marine, hypersaline and lacustrine settings. Integration of field data with existing exploration seismic data and core sections will help to correlate the basin margin and center deposits.

Education and Research Collaboration

Prof. **Seifu Kebede**, Head of the School of Earth Sciences, outlines the present structure of studies in Earth Sciences at AAU, which were founded in the 1950's. The department comprises 30 academic staff, 4 technicians and 2 administrative support staff.

Undergraduate studies comprise four years. Master studies offer 14 possible specializations, among which – as potentially relevant to the consortium studies – e.g. Tectonics and Geodynamics, Petrology, Exploration and Mining, Paleoenvironment.

There are three PhD programmes: Hydrogeology, Structural Geology, Geophysics. Incentives towards growth and diversification aim to meet the needs of a diversifying economy, but constraints exist at the level of capacity. PhD research has benefitted in the past from international interest in rift studies, focusing on rift geodynamics and volcanism, flood basalts, geothermal resources, paleoenvironment, lacustrine sediments and groundwater resources of the rift. An important boost was given by French-Ethiopian collaboration: about one third of the academic staff has been trained in France.

Analytical facilities comprise laboratories for hydrogeology and physical hydrology, geochemistry and isotope studies (^{222}Rn), paleomagnetism, engineering geology and remote sensing. Coring facilities are available. The laboratory for isotope studies is supported by the International Commission for Atomic Energy, and hosts students from Kenya and Tanzania.

The Earth Sciences department provides services to Society in the fields of groundwater mapping, exploration geophysics, GIS, as well as short term training in various disciplines.

Strategic issues:

- Establishing a Geodynamics and Earth Observation Center: there is a high priority to develop a center focusing on remote sensing linked to geology.
- Developing the undergraduate studies to better respond to the current needs of Society, in particular in the fields of exploration and mining geology, remote sensing, isotope hydrogeology, paleoenvironment.
- Consolidating and developing advanced research in geophysics, exploration, petrology, remote sensing, soft rock geology.
- Developing a Center of Paleoenvironmental Research.
- Stabilizing staff positions: there is a chronic problem of keeping high-level staff.

Prof. **Anneleen Foubert** outlines the grant system in Switzerland and at the University of Fribourg. At national level, the Swiss National Science Foundation (SNF) provides PhD grants within research projects (annual calls) and the Swiss Programme for Research on Global Issues (r4d). Specific PhD scholarships, postdoctoral scholarships and research scholarships for senior scientists are also offered on base of annual calls.

The exchange of teaching and research experience between the University of Fribourg and Addis Ababa University will be largely facilitated by the Memory of Understanding, very recently signed between both institutions. The two universities agree in particular to (a) exchange information in the fields of interest of both universities, (b) exchange invitations to scholars for lectures, talks, and sharing experience, (c) exchange students and (d) engage in other activities to better enhance mutual understanding and cooperation.

Prof. **Jean-Pierre Henriet** reports on the opportunities shaped by the Flanders council for research for development VLIR-UOS. Ethiopia is a key partner country, which benefitted of some 25.5 MEuro in the decade 2003-2013. This translated in some 667 individual grants over the concerned period (55 PhD fellowships, 279 short visit grants, 333 Master scholarships). Cooperation with Mekele and Jimma universities has reached

the level of long term Institutional University Cooperation (IUC, 12 years commitments, empowering universities as local development actors). A toolkit of 12 project formats is available, from short term entry level projects at department level, over educational and institutional cooperation, up to country level cooperation schemes. Ghent University contributes to two master programmes of possible relevance: Physical Land Resources and Marine and Lacustrine Sciences. A Ghent- and Mekele-coordinated VLIR-UOS TEAM project - the "Graben-TEAM" - focuses on sustainable land management in the marginal graben midslope the Escarpment, close to the Danakil depression.

In the **Discussion** concluding this morning session, a large attention is paid to the spirit of collaboration, in due respect of "fair science". It is stressed that the MOU between Fribourg University and Addis Ababa University commits to cooperate in developing friendship and mutual interests on a reciprocal basis of respect for the independence and equal status of each university.

Academia-Industry Discussion

The participants are welcomed by the Chairs. The Industry delegates wish to acknowledge this invitation and confirm the importance of exchanging information on this very active geological environment.

Before addressing the scientific issues, Anneleen Foubert enquires about security and health issues, in view of the imminent departure of the second expedition. Industry delegates provide health advice and courteously commit to significant field assistance. Allana Potash will assist by providing radio links to their Movement Control Department, and Search & Rescue services in case of emergency. On site medical facilities are operational. Security threats are minimal, not the least by the proximity of military bases.

A considerable amount of data is available for study. Over a 100 M\$ has been spent for exploration. Allana Potash being a public company and having its exploitation license, access to data is not an issue. Circum Minerals and Yara Dallol are not public companies, but are keen to contribute to academic research, in due time (the granting of their exploitation license is pending). There are about 32,000 m of cores from some 90-100 holes in the Allana license area alone. Yara Dallol has drilled some 25-35 holes, among them the deepest hole of the basin (924m). Circum Minerals drilled some 60 holes, with a focus on the eastern part of the basin. They encountered both young salt and old salt. Surface geophysics and downhole geophysical logs are kept at the camp sites. Sampling of the cores should not be a major issue. One has moreover to take into consideration that evaporite cores can degrade with time – the sooner the cores are investigated, the better. Questioned about the possibility of a deep microbial biosphere in the evaporite basin, the Allana Potash confirms the temperature at 200m depth is no more than 60°C.

The Industry partners confirm their interest in the understanding of the development and evolution of the basin, which can lead to a better insight in the genesis and spatial distribution of the potash deposits. On top of that, they are keen to see the development of education and training in mining engineering and surveying related to mining in Ethiopia. The development of solution mining is a highly specific technology and requires skills, mastered by only few engineers in the world. It is complex chemistry. The Danakil deposits of potash rank third in the world in terms of recoverable reserves, and will support over 50 years of exploitation. The present engineering staff is quasi exclusively composed of expats, which is not a sustainable situation. The training of qualified manpower to support the potash mining in Ethiopia should be high on the agenda, for

the benefit of all parties. The Industry partners consider the present dialogue as an historical opportunity.

Research in the Afar Depression

Prof. **Tesfaye Kidane** outlines the history of geological mapping, which started in the Afar in the 1970's. A significant contribution was made through a French-Ethiopian collaborative phase in the 1980's.

The recent geological history of the East African Rift and the Afar triple point is illustrated by some paleogeographical reconstructions, starting 35 My ago, when the Arabian and African plates still joined. The Afar hot spot, some 30 My, gave rise to the Ethio-Yemen trap basalts, locally some 1-2 km thick. At about the same time, a proto-rift fracture developed. Courtillot (1998) considered a rifting scheme halfway between active and passive rifting.

An important geological surveying and mapping phase in the early 70's (Jacques Varet, Franco Barberi, Haroun Tazieff, Bannert & Leloup, Ras Mandesha) led to the first detailed geological map of the Afar (Varet 1978). Afar stratoids were initially dated between 4 and 1 My. An early model involving microplates (Barberi, Varet 1977) was later abandoned. In the 1980's, Courtillot coordinated from Djibouti a major Franco-Ethiopian project. About half of the Ethiopian PhD's were trained in France.

The Dabbahu seismic and volcanic event was at the origin of the Afar Consortium 2005-2013, under coordination of NERC. No Ethiopian students got trained in this project.

Prof. **Worash Getaneh** reports on the history of mining in the EAR and the Afar region. Geothermal projects have been initiated both in the Afar and in the East African Rift. Reykjavik Geothermal was implied, though more in the Corbetti Geothermal project than in the Afar. In the Tendaho graben, geothermal wells have been drilled to depths of 1811m, 1989m and 2196m.

With regard to potash mining in the Danakil depression, Allana Potash has been granted a development license, while the licenses for Yara Dallol and G&B (Circum Minerals) are in an advanced phase.

Gold is being mined in the Afar by Stratex since 2008. In the Tendaho graben, gold and geothermics turn out good friends, the common control being faults and fractures. In the Tendaho graben, three fault patterns are joining, but no bonanza zone was found that could warrant an economic development.

Petroleum exploration licenses have been granted in Afar to GPB Global Resources (Gazprom affiliate), Africa Oil, New Age and General Energy, but exploration has been abandoned. Some shallow gas (methane) has been reported above the salt in a Circum Minerals well in Danakil, but the leakage had ceased after a couple of weeks.

Prof. **Jean-Pierre Henriet** reviews a history of drilling and exploration efforts in the Red Sea, the Gulf of Aden and the East African Rift.

In the Red Sea, the discovery of deep brines had led to DSDP Leg 23 of Glomar Challenger in 1973. On Site 230 in the southern Red Sea, Pleistocene carbonate ooze was drilled, containing numerous volcanic ash streaks. The high salinity of the pore water suggested underlying Miocene evaporates, evidenced on seismic profiles by the so-called S reflector. An early compilation of heat flow data (Girdler and Evans 1974)

was made from oil well data, the Valdivia 1970 cruise and DSDP Leg 23. Recent drilling proposals comprise IODP 741-Pre in the Gulf of Suez, submitted by J.R. Hovland (Origin and permeability of salt), and IODP 867-Pre (resubmitted), proposing MeBo200 drilling under the Mission Specific Platform Scheme (Rohling – Red Sea Plio-Pleistocene, paleoclimate).

In the Gulf of Aden, in the wake of the early TADJOURADEN cruise (1995), a suite of French geophysical studies have been carried out largely under the Action MARGES (CNRS-INSU, BRGM, IFREMER, IFP, TOTAL): ENCENS-Sheba MD-117 cruise (2000), ENCENS-FLUX (2006), MARGES-ADEN (2012). In 2012 a research framework agreement encompassing studies in the Gulf of Aden was passed between IFREMER and TOTAL (PAMELA).

Continental drilling proceeded in the East African Rift initially for geothermal research, in the Aluto-Langano field since the 1980's. In the Tendaho graben a license was passed with Reykjavik Invest Cy. In the Dallol region, geothermal opportunities are in the phase of identification. A major problem is permeability (lack of fault zones).

ICDP drilling took place in 2013-2014 in the framework of the Hominin Sites and Paleolakes Drilling Project (HSPDP, coordinator Cohen): Tugen Hills and West Turkana in Kenya, Chew Bahir and North Awash in Ethiopia. Lake Magadi is yet to be drilled. Deep-Challa (coord. Dirk Verschuren, Ghent University), at the border between Kenya and Tanzania on the flanks of Kilimanjaro, has been approved by ICDP. The opportunity and possible terms of reference of an ICDP Danakil Drilling Project are briefly discussed.

Assessment of the results and impact of the event on the future directions of the field

Future action points of forthcoming carbonate research in the Afar have been extensively discussed during a round table discussion, as well as the intensification of the exchange between scientists of Fribourg University and Addis Ababa University.

The following consensus and action points have been discussed:

1. A research proposal to the Swiss National Science Foundation will be prepared and submitted by April 1st, 2015.
2. A PhD management plan outlining areas and themes of interest for Ethiopian and Swiss PhD students in the Danakil region will be drafted.
3. A master profile (W-E) through the Danakil basin will be traced on base of all available data (boreholes, seismic profiles, outcrops, etc.), as possible backbone to prioritize further data collection (existing or new), to identify and address data gaps, and to compile a first full-basin cross section for scientific (publication) and educational objectives – as an early product of the Consortium collaboration.
4. A documented, educational collection of representative samples of Danakil sediments (carbonates, evaporates) at AAU will be prepared with support of Fribourg University, for raising increased student interest at AAU towards Danakil Basin studies.
5. Prof. Seifu Kebede reminds of the importance of developing the capacity of the School of Earth Sciences in terms of remote sensing applied to structural geology.
6. Contacts will be laid with the VLIR-UOS Graben TEAM for further exploring potential synergies and project/capacity building opportunities in the Marginal Graben area.

7. Fribourg proceeds with contacts with STATOIL towards support under the terms of a non-exclusive, non-restrictive (e.g. in terms of publication), open collaboration.
8. An ICDP Workshop proposal will be prepared for submission in January 2016. Balemwal Atnafu and Tesfaye Kidane will be invited to the Monte Verità conference in November 2015, for contributing in finalizing the proposal.

Annexes 4a) Programme of the meeting

January 20th, morning session

Opening Ceremony

- 09:00 *Welcome Speech by Dr. Jeilu Oumer (Academic vice President of Addis Ababa University)*
- 09:15 *Opening Speech by Mr. Ato Tolossa Shagi (Minister of Mines, Ethiopia)*
- 09:30 *Report on the Oct-Nov 2013 Field Reconnaissance (Prof. Anneleen Foubert, Prof. Tesfaye Kidane, Prof. Jean-Pierre Henriet, Dr. Balemwal Atnafu, Dr. David Jaramillo-Vogel)*

10:00 – 10:45 *Coffee break and Discussion*

Education and Research Collaboration

- 10:45 *Education & Research in Earth Sciences at AAU, Ethiopia – Strategic Issues (Prof. Seifu Kebede, Head School of Earth Sciences, AAU)*
- 11:00 *Relevant Education and Research at Fribourg University, Switzerland (Prof. Anneleen Foubert)*
- 11:15 *Relevant Education and Research at Ghent University, Belgium (Prof. Jean-Pierre Henriet)*
- 11:30 *Discussion – Educational added value shaped from Phase I (Items for discussion: potential PhD students both from Ethiopia and Switzerland and PhD programmes, MSc programmes).*

12:00 – 14:00 *Lunch Break*

January 20th, afternoon session

Academia-Industry Discussion

14:00 – 16:00 *Open discussion session between Academia and Industry*

January 21st, morning session

Research in the Afar Depression

- 09:00 *A brief history of Research on the Afar Geology (Dr. Tesfaye Kidane and Dr. Balemwal Atnafu)*
- 09:30 *Mining Developments in the Afar – ongoing projects and outlook (Dr. Worash Getaneh)*

10:00 - 10:45 Coffee break and Discussion

10:45 ICDP and relevant studies in Red Sea – Gulf of Aden & Future Scientific Drilling possibilities in the Afar (Prof. Jean-Pierre Henriot and Dr. Tesfaye Kidane)

11:15 Discussion

12:00 - 14:00 Lunch Break

January 21st, afternoon session

Round table discussion

14:00 – 16:00 Open session of the Afar Carbonate Research Consortium members.

Annexes 4b) Full list of speakers and participants

| Name | Affiliation |
|----------------------------------|---------------------------------------|
| Dr. Jeilu Oumer | Addis Ababa University, Ethiopia |
| Minister Tolossa Shagi | Ministry of Mines, Ethiopia |
| Dr. Balemwal Atnafu | Addis Ababa University, Ethiopia |
| Dr. Tesfaye Kidane | Addis Ababa University, Ethiopia |
| Prof. Anneleen Foubert | Fribourg University, Switzerland |
| Prof. Jean-Pierre henriet | Ghent University, Belgium |
| Prof. Bernard Grobety | Fribourg University, Switzerland |
| Mr. Jean-Charles Schaegis | Fribourg University, Switzerland |
| Dr. David Jaramillo-Vogel | Fribourg University, Switzerland |
| Dr. Worash Getaneh | Addis Ababa University, Ethiopia |
| Dr. Seifu Kebede | Addis Ababa University, Ethiopia |
| Mr. Ermias Filfilu | Addis Ababa University, Ethiopia |
| Mr. Damenu Adefris | Wollega University, Ethiopia |
| Mr. Jason Wilkinson | Allana Potash Corp., Ethiopia |
| Mr. Yonas Bekele | Circum Minerals Potash Ltd., Ethiopia |
| Mr. Habtom Hagos | Circum Minerals Potash Ltd., Ethiopia |
| Mr. Gebregziabher Mekonnen | Addis Ababa University, Ethiopia |
| Mr. Oistein Kostol | Addis Ababa University, Ethiopia |
| Mr. Rhys Coles | Allana Potash Corp., Ethiopia |
| Dr. Agazi Negash | Addis Ababa University, Ethiopia |
| Dr. Teklehaimanot Hailesellassie | Addis Ababa University, Ethiopia |
| Prof. Nigussie Reta | Addis Ababa University, Ethiopia |
| Dr. Mulugeta Alene | Addis Ababa University, Ethiopia |
| Dr. Tilahun Mamo | Addis Ababa University, Ethiopia |
| Prof. Gezahegn Yirgu | Addis Ababa University, Ethiopia |
| Dr. Asfawossen Asrat | Addis Ababa University, Ethiopia |
| Dr. Abera Alemu | Addis Ababa University, Ethiopia |
| Dr. Bekele Abebe | Addis Ababa University, Ethiopia |
| Dr. Getachew Berhan | Addis Ababa University, Ethiopia |
| Dr. Tigistu Haile | Addis Ababa University, Ethiopia |
| Prof. Solomon Tadesse | Addis Ababa University, Ethiopia |
| Dr. Dessie Nedaw | Addis Ababa University, Ethiopia |
| Dr. Tarun Raghuvanshi | Addis Ababa University, Ethiopia |
| Dr. Suryabaghavan | Yara Dallol |
| Dr. Ameha Atnafu | Addis Ababa University, Ethiopia |
| Mr. Amdemichael Zafu | Addis Ababa University, Ethiopia |
| Mr. Tadele Tessema | Addis Ababa University, Ethiopia |
| Mr. Yemane | Addis Ababa University, Ethiopia |
| Mr. Tsedeke Kidane | Addis Ababa University, Ethiopia |
| Mr. Merhawi G/Egziabher | Addis Ababa University, Ethiopia |
| Mr. Assefa Getaneh | Addis Ababa University, Ethiopia |
| Mr. Addis Eshetu | Addis Ababa University, Ethiopia |
| Mr. Haileyesus Delelew | Addis Ababa University, Ethiopia |
| Mr. Berhane Tarafa | Addis Ababa University, Ethiopia |

