Zircon crystallization and the life-times of magmatic-hydrothermal ore systems

C.A. HEINRICH[1], K. MARTINEK[1], M. ERNI[1], A. VON QUADT[1] AND I. PEYTCHEVA[1,2]

[1]ETH Zurich, IGP, CH-8092 Zurich (heinrich@erdw.ethz.ch, vonquadt@erdw.ethz.ch)
[2]Geological Institute, Bulgarian Academy of Science, Sofia, Bulgaria (peytcheva@erdw.ethz.ch)

Magmatic-hydrothermal Cu-Mo-Au ore formation typically involves multiple pulses of subvolcanic porphyry intrusion, vein opening and hydrothermal ore deposition. Porphyry-related ore formation is driven by much larger subjacent magma reservoirs, acting as source of fluid and ore forming components. High-precision U-Pb dating of individual zircon crystals from porphyries that pre- and postdate Cu-Au-mineralization at Bingham Canyon (USA) and Bajo de la Alumbrera (Argentina) show a significant spread of concordant ages. Zircon crystals formed over a protracted period of at least 1 m.y., which is interpreted as the lifetime of large subjacent magma reservoirs from which porphyries and ore fluids were eventually extracted. The youngest zircons in all pre- and post-ore intrusions overlap in a much shorter time interval of 0.09 m.y. (Alumbrera) and 0.28 m.y. (Bingham). The youngest reliably concordant zircons are interpreted to bracket the time and duration of porphyry emplacement and ore formation, not the mean age of large zircon populations as commonly assumed. High-precision dating and a new approach to geological interpretation of zircon ages resolves the apparent conflict between claims of multimillion year durations of porphyry mineralizations and thermal constraints necessitating much shorter time scales of ore formation.

Microbial ecology of terrestrial methane-emitting mud volcanoes in Italy

C. HELLER[1]*, M. BLUMENBERG[1], A. REIMER[1], C. WREDE[2], M. HOPPERT[2], M. TAVIANI[3] AND J. REITNER[1]

[1]Geoscience Centre, University of Goettingen, Germany (*correspondence: cheller@gwdg.de, jreitne@gwdg.de)
[2]Institute of Microbiology and Genetics, University of Goettingen, Germany
[3]ISMAR-CNR, Bologna, Italy

Terrestrial mud volcanoes are formed by the expulsion of water, mud and gases like methane and higher hydrocarbons. Moreover, mud volcanoes often contain various electron acceptors (e.g. O_2, SO_4^{2-}). Therefore, methane is the substrate for various microorganisms, performing either the anaerobic oxidation of methane (AOM) [1] or using other pathways.

Here we present results from different mud volcanoes in Italy (near Bologna and on Sicily). The mud volcanoes of 'Salse di Nirano' near Bologna were found to emit high amounts of methane (80 to 99 %) with $\delta^{13}C$ values indicative for a mostly thermogenic origin (-47 to -54‰). Organic-chemical analyses of the mud revealed signals of various eukaryal, bacterial and archaeal organisms. In addition to signals from higher plants, most likely sourced by the surrounding flora and soils, specific bacterial dialkyl glycerol diethers (DAGE; in particular ai15/ai15 and 16/16) were found which are putatively sourced by sulphate-reducing bacteria (SRB) [2]; [3]. The presence of archaea is evidenced by archaeol and hydroxyarchaeol. Isotopic analyses of SRB-derived DAGE as well as hydroxylarchaeol demonstrated ^{13}C-depletions with $\delta^{13}C$ values up to -54‰, suggesting an involvement of the source organisms in the anaerobic turnover of methane [4].

Our data show that the complexity of microbial communities in the different mud volcanoes is very high. In contrast to 'Salse di Nirano' mud volcanoces, in settings, where underlying, geological gypsum formations are lacking, methane turnover appears to be mostly accomplished by aerobic pathways. Here biomarkers of SRB were absent while ^{13}C-depleted hopanoids were found suggesting that methanotrophic bacteria are key-players in these environments.

Additional analyses of mud volcanoes on Sicily are underway to gain deeper insights into these systems. Some of the mud volcanoes on Sicily developed a few hours after an earthquake last year.

[1]Alain *et al*. (2006), *Environ Microbiol* **8** (4) 574-590. [2] Pancost *et al*. (2001) *Org. Geochem* **32** (5), 695-707. [3] Blumenberg *et al*. (2004) *PNAS* **101** (30) 11111-11116. [4] Heller *et al*. (in press) Lecture Notes in Earth Sciences.