Influence of impacts on the deep subsurface biosphere

A.L. GRONSTAL[1], M.A. VOYTEK[2], K. FINSTER[3], J. KIRSHTEIN[2] AND C.S. COCKELL[1]

[1]CEPSAR, Open University, Milton Keynes, MK7 6AA, UK
[2]USGS, Reston, VA, USA
[3]Aarhus University, 8000 Aarhus C, Denmark

The aseptic collection of samples from a 1.8 km core recovered from the deep subsurface of the Chesapeake Bay impact structure, Virginia USA, under the auspices of the USGS-ICDP has allowed for the study of the influence of asteroid and comet impacts on microbial communities in the deep subsurface. The ~85-km diameter crater was formed in the late Eocene and is today one of the best preserved craters formed in a shallow marine environment. The project also allowed for insights into microbial abundance in the terrestrial deep subsurface in general.

Microbiological enumeration and culture and culture-independent methods coupled with geochemical data suggest the presence of three major microbiological zones. The upper zone (0-700 m) is characterised by a logarithmic decline in microbial numbers from the surface into the upper layers of the impact tsunami resurge sediments. The impact-mixing of diverse lithologies within these crater-fill sediments has created a geochemically heterogeneous substrate. The presence of organisms in this zone is confirmed by microscopy and both culture and culture-independent methods. The middle zone (700-1400 m) corresponds to the region that has low hydraulic conductivity and in its deeper sections may have been sterilized by the thermal pulse caused by impact. Culture and culture-independent methods show a biologically impoverished environment. The lowest zone (>1,560 m) is a region of heavily impact-fractured, hydrologically conductive target schist/pegmatite in which microbial cell numbers are higher than the middle zone and heterotrophic organisms have been cultured.

These results reveal the nature of impact disruption to the subsurface biosphere. They show how the deep subsurface is also affected by catastrophic changes caused by asteroid and comet impacts that have previously been suggested to have caused severe perturbations to surface biological evolution in the past. However, the data show that deep impact fracturing and geological disruption can in some instances benefit subsurface communities by increasing the availability of surfaces and the flow of redox couples and nutrients.

Determining mineral solubilities at HP and HT using new geometric and birefringence approaches

J. GROSS[1]*, W.V. MARESCH[1] AND M. BURCHARD[2]

[1]Ruhr-University of Bochum, D-44780 Bochum, Germany
(*correspondence: Juliane.Gross@rub.de)
[2]Rubrecht-Karls-University Heidelberg, D-69120 Heidelberg, Germany

The role of fluids in the reequilibration of minerals and rocks is fundamental to understand the mechanisms and kinetics of metamorphic and metasomatic processes. Data for the solubility of minerals in aqueous solutions at high pressures are essential for our understanding of fluid properties, mass transport and growth/dissolution processes of minerals in Earth's crust and upper mantle.

Although a fairly extensive dataset is now available on the solubility of minerals in aqueous fluids at HP and HT (e.g. [1]), almost all of the data above 0.5 GPa have been obtained by *ex situ* quench methods in piston-cylinder apparatus. A few comparative studies between such indirect weight-loss techniques and direct disappearance-of-phase, *in situ* methods are available, but only for trace elements [2]. The results show huge differences, which so far have not been satisfactorily explained.

We have developed new approaches for determining solubilities of dissolved components using a specially designed hydrothermal diamond anvil cell (HDAC) This construction allows fluid-pressures of up to 4.0 GPa to be reached [3].

In the first method we exploit the tendency of crystals to approach an idiomorphic habit during HDAC runs, as observed by [4], and also in our own HDAC studies. By defining the habit of a crystal before the run, its changing geometry can be modeled at various stages of the experiment and solubilities can be calculated.

The second method is based on measuring and analysing mineral birefringence to quantify the thickness of the crystal. Changes in crystal volume can be directly obtained. With this method crystal weights less then a few µg can be determined. First measurements on calcite, quartz and gypsum will be presented. The results are needed to define the chemical and physical properties of fluids in subduction zone models.

[1] Newton & Manning (2002), *Am. Mineral.* **87**, 1401-1409. [2] Tropper & Manning (2005) *Am. Mineral.* **90**, 502-505. [3] Burchard, Zaitsev & Maresch (2003) *Rev. Sci. Instr.* **74**, 1263-1266. [4] Wang, Henderson & Brenan (2005) *Geochim. Cosmochim. Acta* **68**, 5197-5204.