Scientific drilling of the Boltysh impact crater, Ukraine

Conference or Workshop Item

SCIENTIFIC DRILLING OF THE BOLTYSH IMPACT CRATER, UKRAINE. J.S. Watson[1,2], I. Gilmour[1], S.P. Kelley[2] and D.W. Jolley[3]. [1]Planetary and Space Sciences Research Institute, The Open University, Milton Keynes, MK7 6AA, UK, [2]Department of Earth and Environmental Sciences, The Open University, Milton Keynes, MK7 6AA, UK, [3]Department of Geology and Petroleum Geology, University of Aberdeen, AB24 3UE, UK.

Introduction: The Boltysh crater has been known for several decades and was first drilled in the 1960s as part of a study of economic oil shale deposits. Unfortunately, the cores were not curated and have been lost. We have re-drilled the impact crater and have recovered a near continuous record of ~400 m of organic-rich sediments together with 15 m of suevite. The sediments were deposited in a deep isolated lake and span a period ~10 Ma.

The Boltysh crater: The Boltysh impact crater, centred at 48°54'N and 32°15'E, is a complex impact structure formed on the crystalline basement rocks of the Ukrainian shield, which comprise porphyroblastic granites (age ca. 1.55 Ga) and biotite gneissses (age ca. 1.85 – 2.22 Ga) [1]. The structure is covered by Quaternary sediments and has been dated at 65.17±0.64 Ma [2]. At 24km diameter, the impact is unlikely to have contributed substantially to the worldwide devastation at the end of the Cretaceous. However, the precise age of the Boltysh impact relative to the Chicxulub impact and its location on a stable low lying coastal plain which allowed formation of the post-impact crater lake make it a particularly important locality. After the impact, the crater quickly filled with water, and the crater lake received sediment input from the surrounding land surface for a period in the region of 10 Ma [1]. These strata contain a valuable record of Paleogene environmental change in central Europe, and potentially one of very few terrestrial records of the KT event. This pre-eminent record of the Paleogene of central Europe can help us to answer several related scientific questions. What is the relative age of Boltysh compared with Chicxulub? How long was the hydrothermal system active for after the impact event? How did the devastated area surrounding the crater recover, and how rapid was the recovery?

Scientific drilling: A single core was recovered from the central area of the 24km diameter crater comprising a near continuous sequence of sediments between 175m and 599m, the lowermost 15m consisting predominantly of a polymict suevite breccia (Figure 1a). The clast size varies within the impact breccia on a mm to cm scale and there is extensive evidence of secondary hydrothermal activity. A sharp. 45°, angular contact marks the boundary between the impact breccia and the overlying sedimentary deposits (Figure 1b).

The first sediments to be deposited in the crater lake occur at 581.5m and comprise a series of thin turbidite beds overlain by progressively more organic-rich shales and occasional oil shales. These sediments span a period of up to 10Ma and contain occasional macrofossils, including ostracods, fish and plant fossils. Preliminary palynological studies suggest that initial sedimentation rates in the crater following the impact may have been low followed by more rapid sedimentation through the Late Paleocene.

Figure 1. Images of core material recovered from the Boltysh impact crater. (a) Suevite breccia from a core depth of 580.9m and (b) Contact between suevite breccia and overlying lacustrine sediments at 581.5m.

Preliminary organic geochemical analyses. A detailed organic geochemical survey of the crater fill sediments is being undertaken. Samples have been selected at relatively high resolution immediately above the suevite/sediment contact (ca. 20 cm intervals) extending to metre resolution further up the core section. All samples for organic analyses were collected and stored in aluminium foil to reduce the risk of plasticizer contamination. Following solvent extractsion using dichloromethane/methanol, hydrocarbon extracts have been analysed by gas chromatography mass spectrometry (Figure 2).

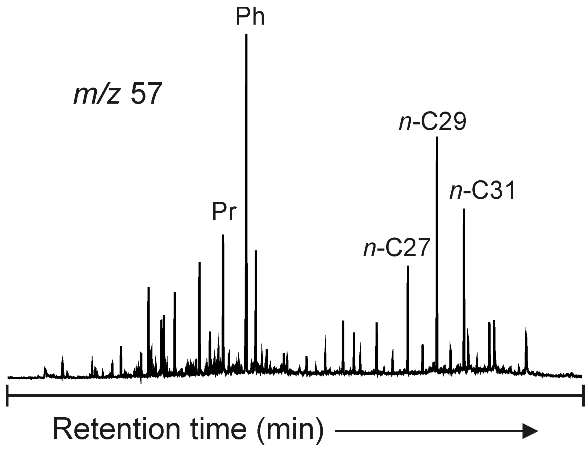

Figure 2. Typical partial chromatogram (m/z 57) of a solvent extract from the middle of the core.

Hydrocarbon exracts from organic-rich sections of the core are commonly dominated by terrestrial *n*-alkanes. Hopanes (including 3-methylhopanes) and steranes are also abundant and indicate a low level of organic maturity for the samples. The immaturity of samples is also evident from the abundance of hopenes, sterenes and oleanenes especially in the upper section of the core. In some of the oil shales the hopenes and sterenes are the most abundant hydrocarbons present. There is variation in the distribution of hydrocarbons/biomarkers throughout the core caused by changing inputs and environmental conditions.

References:

[1] Gurov, E.P. et al. (2006). In: Cockell, C., Koeberl, C., Gilmour, I. (Eds.), Biological Processes Associated with Impact Events, Spinger-Verlag, Berlin pp. 335-358. [2] Kelley, S.P., Gurov, E. (2002) Meteorit. Planet. Sci. 37, 1031–1043.