Geophysical Research Abstracts
Vol. 13, EGU2011-11890, 2011
EGU General Assembly 2011

The puzzle of an impact crater in siliceous volcanic rocks: preliminary characterization of the El'gygytgyn ICPD drill core

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The 18 km-diameter El'gygytgyn impact structure, centered at 67°30′N and 172°34′E, in the central Chukotka region, northeastern Russia, is the only known impact structure on Earth that was excavated in siliceous volcanic rocks. The Late Cretaceous volcanic sequence comprises mostly ignimbrite, tuff, and rhyolitc-dacitic lava, with local occurrence of andesites and andesitic tuffs. The impact was dated from impact glasses to ∼3.6 Ma. The crater is filled by a 12 km-wide and 170 m-depth lake. In 2009, the El'gygytgyn impact crater was drilled within the framework of an ICDP (International Continental Scientific Drilling Program) project. The aim of studying the drill core is to investigate shock metamorphism in these rocks, as a possible planetary analogue, and to find criteria to distinguish volcanic and impact-derived features. The studied core begins at 318.83 m below the lake floor, underlying the post-impact sedimentary sequence, and terminates at 517.30 m. From the over two hundreds samples collected along the core, about 60 thin sections and 20 powdered samples were selected for preliminary observations. Methods that will be used for investigations include optical and electron microscopy, both supplemented by image analysis, X-ray fluorescence spectrometry, instrumental neutron activation, X-ray powder diffraction, micro-Raman spectrometry and energy dispersive X-ray analyses.
The classification of the core lithology is not straightforward due to strong alteration of the samples and because shock effects on volcanic rocks are still not completely understood. In absence of clear shock evidence such as PDFs in quartz grains, the shocked samples might potentially be indistinguishable from the unshocked volcanic rocks. A rough classification is proposed: (1)top of the core to ∼328 m depth: breccia including sediments, volcanic/impact glasses (from porous whitish pumice to reddish rhyolite, to black basalts-like); (2)∼328-∼423 m: a wide transition zone with mixed lithologies and pervasive fractures;(3) ∼ 423 m to the bottom of the core: quite homogeneous greenish altered rock, with clastic to microcristalline siliceous matrix, rounded grains of quartz, feldspars, rare biotite/hornblende, abundant angular melt particles and characterized by a fluidal fabric with 30-60° dip. At this time, it is unclear whether the latter lithology is impact related, based on observed microstructures (e.g. in isotropized quartz and melt particles). We interpret it as impact related, considering that a ∼80 m thick layer of shocked rock is inconsistent with a 18 km-diameter impact crater and that a large unshocked megablock should have been identified by seismic reflection before drilling. The preliminary geochemical analysis shows evidence for anomalously high Co, Cr, and Ni contents, which might be interpreted as due to either meteoritic contamination or hydrothermal alteration, in samples from the depth 420.93 and 422.9 respectively. Further investigations of the melt particles and the geochemical anomalies are in progress.