

Thermal history of andesitic achondrite Erg Chech 002

*Akira Yamaguchi¹, Atsushi Takenouchi¹, Jean-Alix Barrat²

1. National Institute of Polar Research, 2. UBO-IUEM

Petrologic and geochemical study of asteroidal achondrites is essential to understand the earliest volcanism on planetesimals and protoplanets. These differentiated bodies were likely covered by crust formed by the melting of the parent bodies. Such crustal rocks are divided into basaltic and andesitic types. The majority of basaltic types are eucrites. In contrast, the andesitic type is very rare. We present the petrology of a newly-found andesitic achondrite Erg Check 002 (EC 002) and discuss its petrogenesis and thermal history. We studied polished sections of EC 002 using an FE-SEM equipped with EDS/EBSD/CL system, an EPMA, and a Raman spectrometer.

The section of EC 002 is an unbrecciated rock with medium-grained groundmass with pores. It consists of lath-shaped feldspar, anhedral pyroxene, silica minerals, with minor minerals such as spinel, ilmenite, Ca-phosphate, troilite, and FeNi metal. Silica minerals are cristobalite and tridymite (PO), with no quartz, confirmed by Raman spectra and CL observations. Groundmass pyroxenes are partly equilibrated and consist of relict augite with fine exsolution lamellae of low-Ca pyroxene or relict low-Ca pyroxene with fine exsolution lamellae of augite. In addition, EC 002 also contains angular to rounded pyroxene or olivine xenocrysts. EC 002 is slightly shocked. Bulk groundmass pyroxene compositions are generally augitic (Wo_{27.7}-33.0En_{36.9}-38.5). Feldspars are albitic (Or_{2.0}-7.1Ab_{75.8}-87.4) and contain lamellae of K-rich feldspar. The pyroxene xenocryst has a chemically homogeneous core (Wo_{4.7}En_{76.8}) with zoned rims. There is no difference in the FeO/MnO ratios (~21) between the xenocryst and groundmass pyroxene. The texture of the second section is slightly different, which contains four xenocrysts (1-7 mm in size). One elongated xenocryst is surrounded by a fine-aggregate of pyroxene and feldspar. Compared to the first one, this section contains little amounts of pores. The textural difference may have resulted from the difference of local cooling rates. A further petrologic study of this sample is still in progress. The bulk major chemical compositions of the groundmass are andesitic (58 wt% SiO₂ and 4.54 wt% Na₂O and K₂O). Other REE abundances are low and of the order of 5 or 6 times the chondritic reference.

The petrologic and geochemical data indicate that EC 002 experienced two-stage cooling history. The first stage is the crystallization from lava at ~1200 to ~1000 °C at ~5°C/year, estimated from the compositional profile of Mg# in the pyroxene xenocryst. The second stage is the rapid cooling from ~900 °C, estimated from the occurrence of silica minerals. The sudden change of cooling rates can be explained by rapid cooling caused by impact excavation, consistent with the shock features. The presence of xenocrysts (olivine and pyroxene) gives an impression that EC 002 is an impact melt breccia. However, we do not have a definitive answer to this question. The identical FeO/MnO ratios may indicate the genetic linkage of the pyroxene and xenocryst. The groundmass compositions can only be explained by partial melting, not by impact melting unless the target was andesitic crust.

Keywords: achondrite, andesite, planetesimal, volcanism