Classification of Antarctic meteorites using polished thick sections

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Initial classification of Antarctic meteorites is one of the essential curatorial tasks at the Antarctic Meteorite Research Center, National Institute of Polar Research, Japan. We have been classifying Antarctic meteorites on the basis of petrographic observations of polished thin sections and compositions of olivine (Fa), pyroxene (Fs), and/or feldspar (An, Or) obtained by an electron microprobe analyzer (EPMA) (e.g., Yamaguchi et al. 2016).

Recently, we started classifying meteorites by observations of polished thick sections mounted in epoxy (2.5 cm in diameter, ~4-5 mm thick). The sections are examined by an optical microscope (reflected light) and the EPMA. Typical numbers of analyses by the EPMA are ~30-40. The main advantages of using polished thick sections are to significantly reduce time and cost (i.e., expertise) of sample preparations. For carbonaceous chondrites, diagnostic features such as sizes and abundances of chondrules and matrix, minerals (mafic minerals, feldspar, oxide minerals, FeNi-metals, and sulfides) can be easily identified under reflected light. Carbonaceous chondrites are classified on the basis of chondrule sizes, chondrule/matrix ratios, metal abundance, and olivine compositions (e.g., Weisberg et al. 2006). There are no serious problems for achondrites, which are classified on the basis of petrographic textures and mineral compositions (e.g., Fa, Fs, FeO/MnO ratios of pyroxene). However, some petrographic textures are difficult to observe (e.g., breccia textures of diogenites).

There are problems for classification of petrologic types of ordinary chondrites using standard scheme, in particular type 3 and 4 (Van Schums and Wood 1967). Identifications of some key mineralogical features (glass, plagioclase, and structural state of low-Ca pyroxene) are very difficult or impossible. Thus, we slightly modified the scheme. The criterior for classifying chondrite is presented in Table 1.

Table 1. Criteria for classifying petrologic types of chondrites by reflected light microscopic observations and EPMA analyses (after Weiseberg et al. 2006).

Criterion	1	2	3	4	5	6
Chondrule-matrix integration	No chondrules	Sharp chondrule boundaries		Abundant chondrules can be discerned	Some chondrules can be discerned	Rare chondrules, poorly delineated
Homogeneity of olivine compositions	-	≥ 5% PMD		< 5%	Homogeneous	
Secondary feldspar	No secondary feldspar			Rare, almost < 2 μm	< 50 μm	Abundant, > 50 μm
Mesostasis in chondrule	-	Turbid	Clean to partly devitrified	Devitrified	Fine-grained secondary plagioclase	Coarse-grained secondary plagioclase
Opaque minerals in matrix	Secondary sulfide	So-called PCP	Fine-grained metal and sulfide intergrowth	Medium to coarse-grained metal and sulfide		

References

Yamaguchi A. et al. (2016) Meteorite Newsletter Vol 25, 25 pp.
Van Schmus W.R. and Wood J.A. (1967) A chemical-petrologic classification for the chondritic meteorites. Geochim. Cosmochim. Acta 31, 747-765.