PETROGRAPHY OF FINE-GRAINED DOMAINS IN UNGROUPED ACHONDRITE ERG CHECH 002: EVIDENCE FOR DIFFERENT COOLING HISTORIES?

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Introduction: The nature and extent of the first volcanic processes occurring on planetesimals in the early solar system are largely unknown due to a scarcity of meteorites that probe and document these processes. Partial-melting experiments performed with chondritic materials [1] suggest that felsic, andesitic or trachyandesitic partial melts were extracted from primitive chondritic materials in early, partially differentiated planetary bodies. Evidence for such non-basaltic, early magmatism has indeed recently been found in the form of some rare achondrites such as Graves Nunataks 06128 and 06129, the Almahata Sitta trachyandesite, and Northwest Africa 11119 [2–4]. More recently, the discovery of Erg Chech (EC) 002, an ungrouped, high-Mg andesite achondrite of a bulk composition reminiscent of Earth's upper continental crust [5–8], has shown that silicate differentiation after metal–silicate equilibration and production of felsic crusts were occurring within the first two million years of solar system history. Here, we report on so far undescribed, fine-grained domains in EC 002 that shed further light onto the meteorite's crystallization history.

Results and Discussion: Five individual slices of EC 002 were screened by micro X-ray fluorescence analysis (µXRF) for bulk chemical composition and modal abundances. The occurrence in two of the five slices of so-far unknown, distinctly fine-grained domains, set within the previously described [5–8], medium-grained lithology of EC 002, became apparent from µXRF element-distribution maps (Figs. 1A, B). Subsequent SEM/EDS and EPMA investigations suggest that the medium-grained domains of our samples are petrographically similar to those described previously [5–8]. In contrast, the fine-grained domains show unbrecciated, igneous textures (Figs. 1A–D) composed of pyroxene megacrysts set in a fine-grained matrix of lath-shaped augite ($Wo_{\sim37}En_{\sim45}Fs_{\sim18}$) and low-Ca pyroxene ($Wo_{\sim5}En_{\sim57}Fs_{\sim38}$), interstitial, lath-shaped, sodic plagioclase ($An_{\sim18}Ab_{\sim79}Or_{\sim4}$), and accessory silica, chromite, and iron sulfide. The megacrysts are compositionally variable (Fig. 1E) and similar to megacrysts in the medium-grained domains, but appear more rounded and numerous than those in the medium-grained domains. Notably, they invariably lack the distinct overgrowth of groundmass augite that is typical for the medium-grained domains (Fig. 1B; [5–8]). Groundmass pyroxenes in the fine-grained domains have Mg# intermediate between the megacrysts and the groundmass pyroxenes in the medium-grained domains (Fig. 1E; cf. [7,8]), suggesting a slightly more primitive nature of the melt and earlier crystallization. µXRF analyses of bulk compositions are forthcoming.

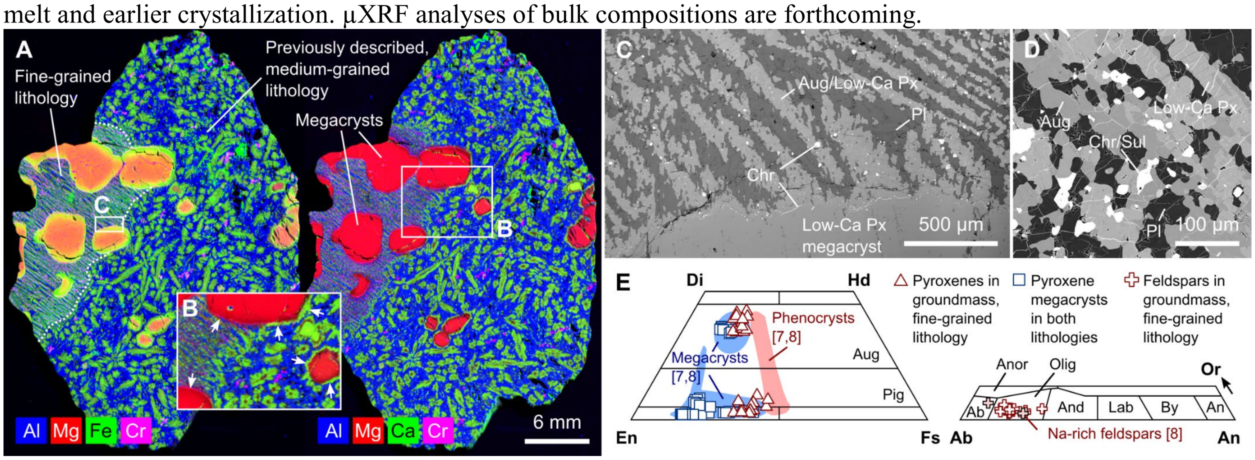

Fig. 1 A, B µXRF element-distribution maps of medium-grained and fine-grained domains in EC 002. **C, D** BSE images of the interface between a low-Ca pyroxene megacryst and groundmass in and details of the fine-grained domain, respectively. **E** Compositions of groundmass pyroxenes, megacrysts, and feldspars.

Conclusion: Our results suggest that the fine-grained domains are not impact melts, but were magmas related to the medium-grained domains that cooled more rapidly and possibly crystallized prior to the medium-grained domains.

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