Origin of low-Ca pyroxene megacrysts in martian basalts. Comparisons among the composition of minerals in RBT 04262. P.V. Burger\textsuperscript{1}, C.K. Shearer\textsuperscript{1}, and J.J. Papike\textsuperscript{1}\textsuperscript{1}Institute of Meteoritics, Department of Earth and Planetary Sciences, University of New Mexico, Albuquerque, New Mexico 87131 (pvburger@unm.edu)

Introduction: The origin of olivine megacrysts in olivine-phyric shergottites has long been a point of debate (see [1], and references therein). Shearer et. al. [1] demonstrated that the origin of the olivine megacrysts was varied and ranged from phenocrysts (e.g. Y98), to accumulated phenocrysts (e.g. SaU 005/094) to xenocrysts (e.g. EETA79001 lithology A). Numerous shergottites (and lherzolitic shergottites), such as EETA79001 (lithology A) and NWA 2626, RBT 04262 and RBT 04261, have olivine and orthopyroxene megacrysts. In several meteorites, these early megacrysts appear to crystallize under a different \( f_o^2 \) than later stage crystallizing phases [2]. In some cases, orthopyroxene megacrysts are rimmed by pigeonite that overlaps the composition of groundmass pyroxene [3]. RBT 04262 (paired with RBT 04261) is a rather unique remnant of martian basaltic magmatism that illustrates this textural relationship rather well. The intent of this abstract is to compare differences among mineral (host and inclusions) compositions making up all three textures observed in RBT 04262 to gain a better understanding of the origin of megacrysts in shergottites, the petrogenesis of martian basalts and the nature of the martian crust.

Analytical Methods: Several electron microprobe analytical techniques have been used during the course of this study. Initial observation and major element sample analysis were conducted using the JEOL JXA-8200 electron microprobe at the University of New Mexico, operating at an accelerating voltage of 15 kV, a 20 nA beam current, and ~1 micron spot size. Unknowns were calibrated using a series of C. M. Taylor Company mineral standards. Wavelength dispersive maps (WDS) were also collected using the JEOL 8200, though the beam current was increased to 100 nA. Olivine trace element analyses were collected using a Cameca 4f\textsuperscript{2} Secondary Ion Mass Spectrometer, also at UNM. The SIMS analyses were conducted at an accelerating voltage of 10 kV, a beam current of 15 nA, resulting in a spot size of ~20 microns. A series of certified and in-house mineral samples were used during standardization.

RBT 04262 Textures: Dalton et al. [4] and Mikouchi et al. [5] distinguished three distinct lithologies in RBT. Lithology A consists of coarse-grained, low-Ca pyroxene megacrysts commonly enclosing anhedral olivine and chromite in a poikilitic fashion. Maske-lynite is absent in this lithology. Lithology B consists of a pyroxene, olivine, maskelynite groundmass, defining a texture reminiscent of the lherzolitic shergottites, and lithology C is a high-Ca pyroxene assemblage that appears to represent a reaction zone between lithologies A and B. The plagioclase component in the lherzolitic shergottites (7-13%) is often less than observed in well-crystallized basaltic shergottites. The origin for these orthopyroxene megacrysts could be (1) xenocrysts reacting with adjacent basalt, (2) incorporation of early orthopyroxene from the same or similar basaltic system or (3) oikocrystic growth in which low-Ca pyroxene mineral growth envelopes earlier formed cumulus minerals during crystallization.

Olivine: Olivine shows textural and chemical variability in RBT 04262. Olivine inclusions within pyroxene megacrysts take two forms: those grains which occur as inclusions within the low-Ca portion of the megacryst, and those which are associated with the more Ca-rich areas in the megacryst (e.g. the augitic rim).
we suggest that the augitic areas within the megacryst (Fig. 1b), represent the exterior rim of the megacryst, and the cut of the section is such that a part of the exterior rim has been sampled within the grain (due to crystal orientation). Texturally, olivine inclusions within the megacryst are anhedral, and smaller than the more euhedral to subhedral olivine within the groundmass of this sample. Chemically, olivine inclusions within the low-Ca portion of the megacrysts are also the most magnesian (ranging from 71.0 – 64.0 mol. % Fo), (Fig. 2). More Fe-rich olivine (65.7 – 60.9 mol. % Fo) is found associated with the augitic sections of the megacryst, and these compositions overlap with those olivines which occur in the groundmass of this sample, which contain the most Fe-rich olivine (63.3-58.4 mol. % Fo). Exploratory trace element analyses among olivine inclusions in the megacryst show variability as well. Inclusions found within the low-Ca portion of the megacryst have higher Ni/lower Co relative to those grains included within the more Ca-rich sections of the megacryst. Whether this relationship represents a crystallization sequence or the trace element characteristics of two distinct magmas remains unclear.

Pyroxene: The biggest difference among pyroxene grains from RBT 04262 is textural. Pyroxene megacrysts are much larger and than those pyroxenes which occur within the groundmass of the sample (Fig. 1). Chemically, the major element chemistry of the two pyroxene populations overlap for the most part (Fig. 2). It should be noted that the most Mg-rich (and lowest Ca) pyroxene analyses were collected in inclusion free regions within the pyroxene megacryst. Observation of the Ca WDS map (Fig. 1b) illustrates well the compositional difference between the typical low-Ca portion of the megacryst, and that of the megacryst rim, a difference which can also be seen in the pyroxene quadrilateral (Fig. 2). The compositional change is abrupt; low-Ca portions of the grain vary from a Wo component of 4.2 – 17.7 mol.%, while rim compositions are higher, varying from 28.7 – 36.7 mol.% Wo. This texture does not look as if it represents uninterrupted phenocryst growth; rather, this rim appears to represent a reaction zone between an early formed pyroxene megacryst, and a later stage melt with higher Ca activity.

Conclusion: Textural and chemical evidence from RBT 04262 suggest a multistage history for this sample. Pyroxene megacryst chemistry overlaps substantially with groundmass pyroxene, suggesting that both developed in a similar chemical regime. Megacryst cores, however, are slightly more magnesian (and lower in Ca), suggesting megacryst growth began prior to groundmass pyroxene. Olivine inclusions within this initial pyroxene growth also have a slightly more magnesian composition than olivine found in either the reaction rim or olivine in the groundmass. We suggest that crystallization began with the most Mg-rich olivines, which were included by early orthopyroxene megacryst growth. These olivines are anhedral, and show some evidence for resorption upon inclusion within the megacryst. This megacryst would have been sequestered from the melt which later crystallized the groundmass for this sample. The relationship between the megacrysts and later melt remains enigmatic, and will be the subject of upcoming investigation. Oikocrystic growth appears unlikely, as olivine inclusion chemistry (i.e. Fe and Mg) in the low-Ca portion of the megacryst is distinct from that of olivine inclusions found in the reaction rim and in groundmass pyroxene; the megacryst must have been separated from the groundmass melt for some period during its growth with later reintroduction (or incorporation into an entirely separate system). Reintroduction of the megacryst to the melt may have resulted in the equilibration of the outer zone of the megacryst with the melt (i.e. the development of a Ca-enriched rim). The mechanism for this sequestration (or alternatively, introduction into an entirely different system) is unclear; it is quite possible the megacryst developed in a horizon that crystallized, and may have later been disrupted by a magma of a similar, but more evolved composition. It follows that olivine included in the augitic reaction rim, experienced equilibration and diffusive exchange with the melt.

References: