

PETROLOGY OF AN OPX-OLIV PORPHYRITIC MG-BASALT CLAST IN KAPOETA; David W. Mittlefehldt; Lockheed EMSCO, C23, 2400 Nasa Rd 1, Houston, TX 77058.

In recent years, controversy has raged anew over the question of whether the most primitive basaltic eucrites represent quenched partial melts of the HED (Howardite - Eucrite - Diogenite) parent body or are themselves fractionated melts of a more primitive precursor (1-4). Central to this controversy is the nature of the phase relations of olivine in eucritic melts. Results of phase equilibria experiments indicate that in controlled, laboratory experiments: 1. eucritic melts are saturated with olivine, 2. olivine is in reaction relation with the melt, and 3. the pyroxene-olivine phase boundary at compositions slightly more mafic than eucrites is a reaction boundary (1). These points are considered by many petrologists to indicate that basaltic eucrites are unlikely to represent liquids fractionated from more primitive parent melts. A small, Mg-basalt clast in Kapoeta thin section USNM #4846-1 is an orthopyroxene-olivine porphyry in which the phase relations clearly show that olivine crystallized after extensive orthopyroxene crystallization. As such, this clast is potentially of greater importance for our understanding of HED petrogenesis than its puny size (about 0.5 X 1 mm) would suggest.

PETROLOGY This clast contains abundant orthopyroxene phenocrysts set in a matrix of glass and/or fine-grained, cryptocrystalline material. Orthopyroxene phenocrysts vary from a maximum of ~240 um down to <10 um and include swallow-tailed, hollow and euhedral morphologies. There is a crude preferential alignment of the elongated grains. All orthopyroxene grains contain ferroan rims on the magnesian cores and the smaller grains are generally more ferroan than the larger. Interstitial to the abundant orthopyroxene grains are a few euhedral, ferroan olivines. The grain size of olivine is < 40 um.

This clast does not appear to be an impact melt. A small glassy clast in Bununu also contains phenocrysts of olivine and orthopyroxene. However, abundant xenocrystic grains of pyroxene and plagioclase clearly mark the Bununu clast as an impact melt. No xenocrystic material was observed in the Kapoeta clast.

The orthopyroxenes are strongly zoned. An average of analyses of magnesian cores is $Wo_{2.0}En_{80.0}$ while the most ferroan rim successfully analyzed is $Wo_{3.6}En_{51.1}$. The olivines show only minor zoning and three grains analyzed averaged $Fo_{36.9}$, $Fo_{49.2}$ and $Fo_{50.1}$. The ratio $(Fe/Mg)_{oliv}/(Fe/Mg)_{opx}$ is close to an expected equilibrium ratio (1) for the most ferroan orthopyroxene rim and the magnesian olivine. However, Fe/Mn partitioning between olivine and orthopyroxene is greater than would be predicted (Fig. 1). In addition, the increase in Fe/Mn ratio with zoning in the orthopyroxene is greater than the available partition coefficients (1) would suggest and is greater than observed in a suite of HED basaltic and gabbroic clasts (5). These features may indicate that Fe metal or sulfide was oxidized during crystallization, increasing the FeO content of the melt and, perhaps, forcing the residual melt composition into the olivine phase volume. Regardless of the cause, the textures and mineral compositions clearly show that olivine crystallized after a period of extensive orthopyroxene crystallization.

COMPOSITION A bulk analysis was obtained using an electron microprobe by rastering the beam over an area of ~100 μm^2 and counting 269 such regions. The bulk clast has an $Mg/(Mg+Fe) = 0.566$ and is more magnesian than any HED basalt yet analyzed. The TiO_2 content is 0.47 wt% which would suggest that this clast could be a primitive member of the trace element poor "Trend A" of Hewins (4). The bulk composition plots in the pyroxene phase volume on an olivine-plagioclase-quartz pseudoternary diagram (Fig. 2). The position of the bulk composition and the magnesian orthopyroxene cores and ferroan rims on the phase diagram (Fig. 2) show that crystallization of orthopyroxene alone is unlikely to drive the melt to olivine saturation for any plausible geometry of the phase boundaries.

The significance of this clast for HED parent body petrogenesis is equivocal. Consideration of phase relations and mineral compositions indicates that olivine crystallization is not due to closed system crystallization of the melt. At present, I can only infer that Fe oxidation was responsible for late crystallization of olivine. If oxidation of eucritic melts was common on the HED parent body, than this process may have caused eucrites to become olivine saturated after a period of pyroxene crystallization. Petrologic investigation of this clast is continuing.

REFERENCES: (1) Stolper (1977) GCA 41, 587. (2) Warren (1985) GCA 49, 577. (3) Beckett & Stolper (1987) LPS XVIII, 54. (4) Hewins (1986) Meteoritics 21, 396. (5) Mittlefehldt (1988) GCA, submitted.

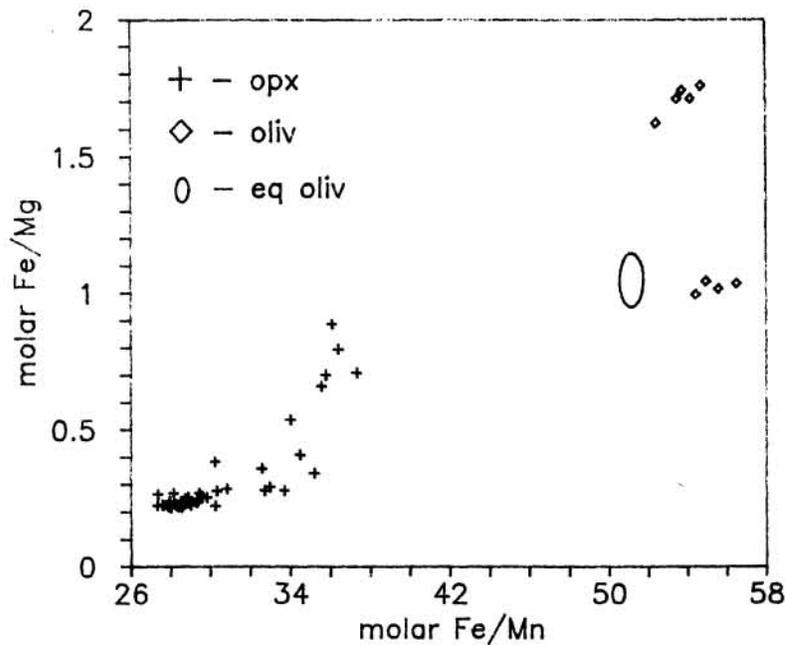


Fig. 1. Molar Fe/Mn vs. Fe/Mg for all spot analyses of orthopyroxene and olivine. The balloon shows the field expected for olivines in equilibrium with the most ferroan orthopyroxene analyses.

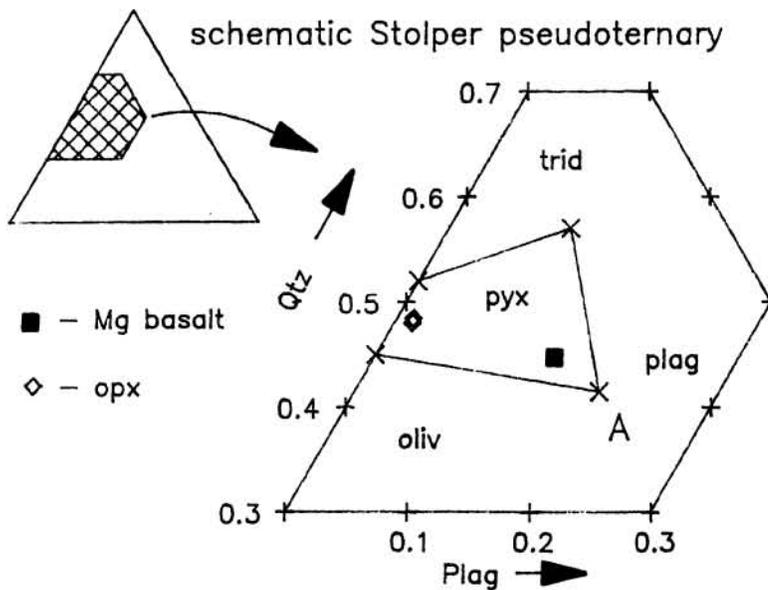


Fig. 2. Schematic pseudoternary diagram for eucrite petrogenesis. Point A represent the inferred piercing point of the olivine-pyroxene-plagioclase peritectic relevant to eucrite petrogenesis.