QUE94201, A NONCUMULATE SHERGOTTITE? Harry Y. McSween, Jr. and Don D. Eisenhour, Department of Geological Sciences, University of Tennessee, Knoxville, TN 37996-1410.

Basaltic shergottites were initially described as cumulates, based on strong preferred orientation of pyroxene grains and non-cotectic compositions [1, 2]. More recent studies have interpreted these rocks as flows that contained some entrained pyroxene crystals [3, 4]; however, the homogeneous magnesian pyroxene cores are assumed to have grown at depth from a larger body of magma, and so in this sense were "cumulus." Although the proportion of cumulus cores has been a subject of controversy, the basic model for their formation has not been questioned (except by [5] who described irregularly zoned pigeonite cores in Zagami). The newly recovered Antarctic shergottite QUE94201 appears not to contain any cumulus crystals.

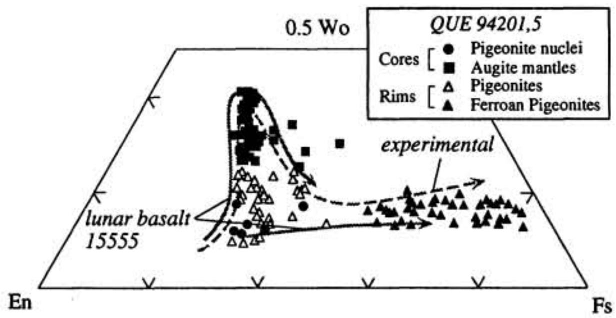
QUE94201 is petrographically similar to the Zagami dark mottled lithology (DML) described by [6]. Modal and electron probe analyses of our section indicate the following composition: clinopyroxenes (44%; relative proportion of pigeonite to augite, estimated from microprobe imaging, is 77:23), maskelynite (46%; An_{66-52}), opaque oxides (2%; ilmenite, titanomagnetite), whitlockite (4%), mesostasis (4%; includes fayalite (Fa_{98}), silica, and pyrrhotite).

Elemental mapping reveals growth features in pyroxenes that have not been previously described in shergottites (Fig. 1). Pyroxene cores consist of nuclei of magnesian pigeonite, mantled by magnesian augite. These composite cores are, in turn, rimmed by ferroan pigeonite, strongly zoned to pyroxferroite. The outer boundaries of the augite mantles are ragged, and a few pigeonite cores are incompletely mantled. These complexly mantled cores are very different from the homogeneous blocky cores commonly found in shergottite pyroxenes. They are reminiscent, however, of pyroxenes described in some lunar basalts. Apollo 15 quartz-normative basalts like 15555 [7] and 15075 [8] have cores of magnesian pigeonite mantled by augite, sequentially rimmed by ferroan pigeonite. In 15555, pigeonite cores continued to grow normal to (010), resulting in incomplete mantling by augite. Ragged augite boundaries resulted from dendritic growth in inclusion-laden sectors [9]. Pyroxene zoning trends in 15555 are compared to those in QUE94201 in Fig. 2.

Mantling of pigeonite cores by augite reflects increasing Ca in the residual melt due to suppression of plagioclase crystallization, and the subsequent displacement of augite by ferroan pigeonite correlated with the onset of plagioclase crystallization. Experimental phase relations [10] indicate that plagioclase crystallization was delayed in these rocks, and its entry was marked by a sudden decrease in pyroxene Al abundance relative to Ti (arrow in Fig. 3). Pyroxenes in QUE94201 show a similar Al decrease (Fig. 3), but at lower Ti content (probably because of higher redox state). It has long been recognized that plagioclase crystallized late in shergottites [1].

Experimental studies of Apollo 15 quartz-normative basalt compositions [10, 11] have reproduced the mineral zoning patterns seen in the natural pyroxenes (arrows in Figs. 2 and 3). However, pyroxenes have grown *continuously* in these controlled cooling rate experiments. A distinct crystallization stage at a slower rate was not required to produce the mantled cores. Rock 15555 cooled at a rate slightly faster than 0.3°/day [12], consistent with an estimated cooling rate for Zagami based on pyroxene exsolution microstructures [13].

There appears to be no reason to argue for two-stage growth of the pyroxenes in QUE94201. If this meteorite contains no cumulus pyroxene cores, it may represent a Martian magma composition, albeit highly fractionated.



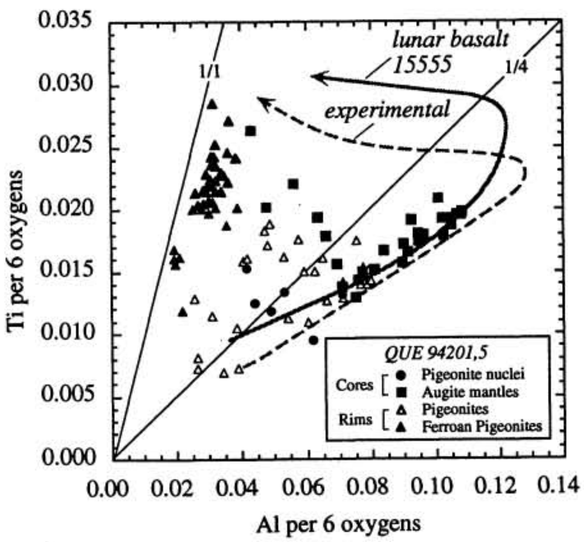


Fig. 1 (upper left): Ca K_α X-ray map showing pigeonite nuclei mantled by augite and rimmed by ferroan pigeonite. Ca from maskelynite and whitlockite has been filtered out. Horizontal dimension is approx 4 mm.

Fig. 2 (upper right): Compositions of pyroxenes in QUE94201. Arrows summarize data for lunar basalt 15555 [7] and experiments on a 15597 analog composition [9].

Fig. 3 (lower left): Ti and Al in QUE94201 pyroxenes. Arrows as in Fig. 2.

References: [1] Stolper E.M. and McSween H.Y. Jr. (1979) *GCA* 43, 1475. [2] Smith J.V. and Hervig R.L. (1979) *Meteoritics* 14, 121. [3] McCoy T.J. et al. (1992) *GCA* 56, 3571. [4] McSween H.Y. Jr. (1984) *Meteoritics* 29, 757. [5] Treiman A.H. and Sutton S.R. (1992) *GCA* 56, 4059. [6] McCoy T.J. et al. (1995) *LPS XXVI*, 925. [7] Bence A.E. and Papike J.J. (1972) *PLSC 3*, 431. [8] Taylor L.A. and Misra K.C. (1975) *PLSC 6*, 165. [9] Walker B.M. and Taylor L.A. (1977) *LPSVIII*, 961. [10] Grove T.L. and Bence A.E. (1977) *PLSC 8*, 1549. [11] Lofgren G. et al. (1974) *PLSC 5*, 549. [12] Walker D. et al. (1977) *PLSC 8*, 1521. [13] Brearley A.J. (1991) *LPS XXII*, 135.