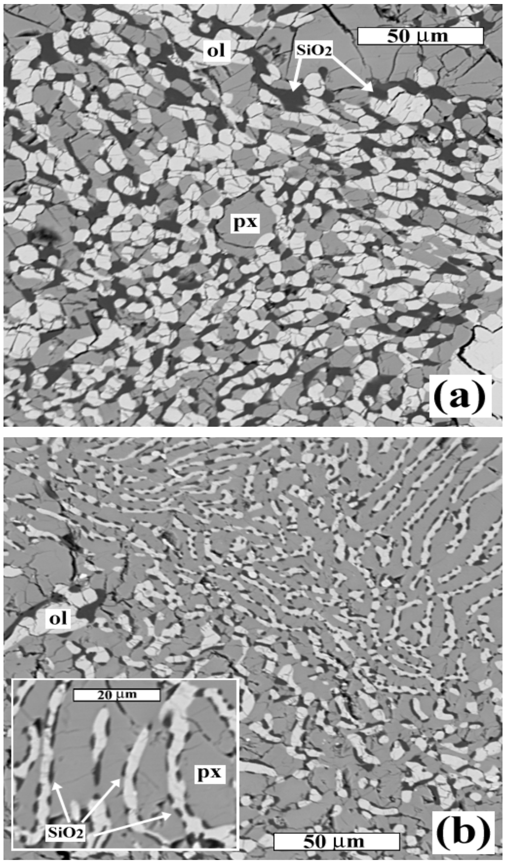

Figure 3. *BSE images of the break-down textures. (a) Minerals are uniformly distributed. (b) Myrmekitic texture with SiO_2 along the boundary between pyroxene and olivine.*

assemblages contain a uniform distribution of minerals (Fig. 3a). However, a few assemblages have distinctive myrmekitic textures (Fig. 3b).

This intergrowth feature of augite, fayalite, and SiO_2 is indicative of the **break-down of pyroxferroite** [9-10] **or pyroxenes with compositions in the "forbidden zone"** (Fig. 4) [8]. The pre-break-down pyroxenes or pyroxinoids were reconstructed using the modal percentage of minerals (analyzed on the BSE image using image analysis software, ImageJ from NIST), the composition of minerals, and their corresponding densities.

For the uniformly distributed texture (Fig. 3a), the reconstructed composition (Fig. 4) lies near the range of lunar pyroxferroite [8]. Pyroxferroite can form metastably at low P and then break-down during slow cooling [9]. In this sample, the lack of pyroxenes with pyroxferroite composition (Fig. 4) suggests that all pyroxferroites broke down due to a homogeneous process affecting the entire rock e.g., cooling.

For the myrmekitic break-down, the reconstructed Fe-rich pyroxene, in the "forbidden zone" (Fig. 4), is similar in composition to the rim of primary pyroxenes. The preferential alignment of olivine and SiO_2 suggests the pyroxene ($En_{12}Fs_{65}$) decomposed to ferroaugite and metastable "ferrosilite", and the "ferrosilite" subsequently broke down to fayalite + SiO_2.

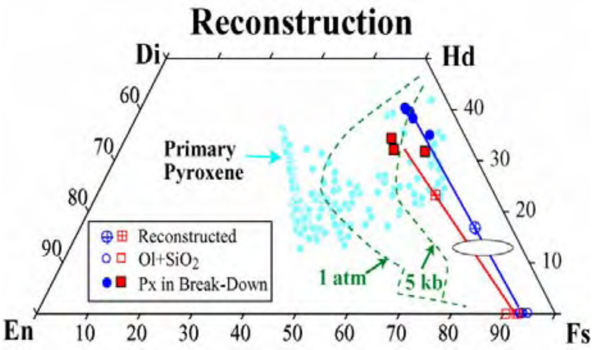

Figure 4. *Reconstruction of the bulk composition for break-down assemblages. Blue symbols are data for uniform assemblage – pyroxferroite breakdown. Red symbols are data for myrmekitic texture. The ellipse is the composition of lunar pyroxferroite [9]. Dashed curves are the left boundary of "forbidden zone"[8].*

The textual and chemical differences between the two types of break-down suggest a different process may have been involved in the formation of the myrmekitic assemblages. **An obvious candidate to provide the activation energy required to initiate this process would be the impact shock that launched this lunar rock into space.** The full conversion of plagioclase to maskelynite involves pressures in the upper end of the vitrification range (30 – 45 GPa [11]), and the mosaicism of pyroxenes involves pressures of 30 – 75 GPa [12]. This may have been sufficient energy to cause the breakdown. That not all pyroxenes with this composition broke down is further evidence for the mechanical nature of the activation of this process.

Comparison with Other Lunar Meteorites: Compared to other lunar gabbroic meteorites (Asuka-881751 [6], Yamato-791369 [7]), MIL 05035 is similar to Asuka-881751 in that primary minerals have similar compositions. However, MIL 05035 contains more Fe-rich pyroxenes and less ilmenite than Asuka-881751. The break-down textures have been reported for other lunar meteorites, but not to the degree observed here.

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