Prtitioning of Al, Ca to olivine grain boundaries, the impact on crystal habit

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The properties of grain boundaries strongly differ from those of the crystal lattice, and there is growing evidence that the presence of grain boundaries influence detected geophysical signals such as electrical conductivity and seismic velocities especially in aggregates with a LPO that favours the alignment of specific grain boundaries. However, neither the anisotropic frequency or or their dependance on chemical compositon are understood in olivine dominated aggregates, neither with nor without LPO.

We used electron backscatter diffraction, EBSD to detect the orientations of over 1.4x104 grains corresponding to roughly 5000mm length of grain boundary separating them. Subsequently we used a stereological approach to determine the grain boundary character distribution, GBCD, defined as the relative areas of grain boundaries of different types, distinguished by their five degrees of freedom (Rohrer, 2007). We analysed olivine aggregates with slightly varying chemical composition especially of Al and Ca fractionated to the grain boundaries.

The grain boundary planes showed a preference for low index planes, which is in agreement with recent findings on other materials (e.g. MgO, TiO2, SrTiO3, MgAl2O4). We find that the principal crystallographic planes have the lowest energies resulting in crystal habits dominated by (001) planes, followed by (010) and (001) planes and that 90°/[001] (100)(010) are the most frequent grain boundaries. However in the abcence of any impurities such as Al or Ca on the grain boundaries the (001) planes dominate the crystal habits. These differences and their influence on different rock properties will be discussed.