

Element mobility during serpentization

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The serpentization process involves the mass transfer of elements by interaction of ultramafic minerals olivine, pyroxene and spinel with externally derived fluids. Major element mobilization and the controlling parameters are still in contention, particularly with regards to Fe mobility and magnetite formation.

Serpentization progression is recorded in a series of vein types. Early rock-dominated veins replacing olivine, type 1 and type 2, are dominated by serpentine ± brucite [1]. Late fluid-dominated, type 3 veins replacing olivine [1], and locally fluid-dominated type 2 veins, contain serpentine ± magnetite. Type O serpentine veins cross-cut pyroxene as an extension of type 2 veins, however type O veins are devoid of brucite and magnetite.

Within serpentized dunites, Fe mobility is recorded by an increase in Mg# ($Mg\# = Mg / (Mg + Fe) * 100$) from serpentine in type 1 to type 3 veins. Brucite associated with each vein type records the same trend in Mg#. Dunite protoliths produce the most magnetite-rich serpentinites.

Within serpentized harzburgites an increase in Mg# is still observed from type 1 to type 2 veins. However, type 3 veins record a decrease in Mg# with respect to type 2, and corresponding increase in the Fe-content of the serpentine.

Here we propose, as serpentization progresses, increases in $aSiO_2$ and changes in the redox budget of the fluid result in instability of ferroan-brucite formed in early vein-types [1][2]. The destabilization of brucite by higher $aSiO_2$, combined with an increase in fO_2 results in the formation of serpentine and magnetite [1][2]. Dunites have optimal conditions for magnetite formation. However, if $aSiO_2$ is high enough, as in serpentized pyroxene domains, brucite formation will not occur, resulting in serpentine as the main Fe-bearing phase [1][2].

Carefully measured in-situ analyses of serpentine, avoiding magnetite, show increase in Fe-content of type 3 veins within serpentized harzburgite as a result of increasing $aSiO_2$ driven by breakdown of pyroxene within the harzburgite. Transfer of elements between serpentized olivine and serpentized pyroxene domains is crucial for the distinct mineral parageneses and Fe-contents observed [1][2].

[1] Frost *et al* 2013. *Lithos*, **72** (22), 5457-5474 [2] Evans *et al* 2013. *Lithos*, **178**, 24-39