Igneous sapphirine in Ambatomena, southern Madagascar

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Sapphirine is commonly thought to be metamorphic, and igneous sapphirine is rare [1]. We examined sapphirine-bearing intrusions of early Paleozoic age (~487 Ma) in Ambatomena, southern Madagascar [2]. The Ambatomena rocks intrude highly deformed granulite facies quartofeldspathic gneisses. The rocks consist of sapphirine, spinel, cordierite, plagioclase and orthopyroxene with subordinate amounts of ruby corundum and phlogopite. The anhedral corundum grains show melt-reaction coronas of spinel and sapphirine. The rocks contain abundant sapphirine-orthopyroxene symplectites and in some places cordierite-orthopyroxene symplectites were developed. Sapphirine grains in contact with corundum and spinel are more aluminous than the 7:9:3 composition (up to 68 wt% Al_2O_3). The sapphirine-spinel geothermometry [3] suggests equilibrium temperatures for the sapphirine-spinel paragenesis around 930~1060°C at 5 kb.

The Ambatomena assemblages represent crystallization of sapphirine and associated minerals from aluminous silica undersaturated melts at high temperatures. Petrographic features suggest the following igneous crystallization sequence; (1) crystallization of corundum from melt, (2) sebsequent reaction of corundum with melt to produce spinel and sapphirine, (3) reaction of spinel with melt to form orthopyroxene and sapphirine, and (4) final crystallization of plagioclase, cordierite, and phlogopite from residual melt. This sequence is broadly comparable to the liquidus phase relations in the forsterite–diopside–anorthite–silica system reported by Liu and Presnall [4].

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Adsorption of MS2 virus to natural organic matter and model surfaces

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Previous studies showed that viruses adsorb to natural organic matter (NOM) surfaces with varying affinities. Adsorption to NOM is an important fate process: it may affect the transport of viruses in the environment and it may enhance virus inactivation because NOM-water interfaces are reactive microenvironments. Despite its importance, virus adsorption to NOM remains poorly understood on a mechanistic level. Here, we systematically studied the adsorption of the bacteriophage MS2, a model virus, to different NOM films and to gold surfaces that were uncoated or coated with self-assembled monolayers (SAM) of alkylthiols with $-CH_3$, -OH, $-COO^-$ and $–NH_3^+$ end groups. The well-defined chemical properties of the gold and SAM allowed assessing the relative contribution of van der Waals forces, the hydrophobic effect, hydrogen bonding and electrostatic forces to MS2 adsorption. The integrities of the formed NOM and SAM films were verified by ellipsometry and contact angle measurements. MS2 adsorption was studied as a function of solution pH and ionic strength using quartz crystal microbalance with dissipation monitoring that has ng/cm^2 sensitivity. Negatively charged MS2 adsorbed to gold and all tested SAM surfaces except to the negatively charged carboxylate-terminated SAM surface. No virus adsorption was detected to the different NOM films at $pH \geq 5$ and low ionic strength ($I = 10$ mM). Adsorption to NOM films increased with increasing ionic strength. These findings suggested that MS2-NOM electrostatic repulsion and possibly steric stabilization forces dominated over attractive interactions arising from the hydrophobic effect, hydrogen bonding, and van der Waals forces. Implications for the interactions of proteins and engineered nanoparticles with NOM will be highlighted.