Deciphering processes and timescales of silicic magma evolution: U-series disequilibria studies of Fogo and Furnas volcanoes, São Miguel, Azores

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The island of São Miguel is the most populous of the nine Azores islands with approximately 150,000 inhabitants, the majority of whom live within 15 km of one of three active stratovolcanoes (Sete Cidades, Fogo or Furnas) that together have produced at least five major caldera-forming eruptions within the past 50,000 years. Fogo volcano has been the source of ~70 explosive trachytic eruptions, most recently in 1563 AD, and Furnas volcano, considered one of the most hazardous in Europe, has produced at least 10 explosive eruptions over the past 3200 years, the most recent being the 1630 AD eruption which killed almost 200 people.

Our ongoing studies on Fogo and Furnas volcanoes are aimed at understanding the nature of the magmatic processes and timescales over which alkaline silicic magmas evolve, including the relative roles of open versus closed system processes in the development of silicic magmas in ocean island settings, and the relationship between pre-eruptive magma residence time and eruptive volume. We have completed detailed petrographic, major and trace element, Sr, Nd, and Pb isotope and U-series disequilibria studies of whole rock, glass and mineral separates from stratigraphically controlled sequences through three chemically zoned, trachyte pumice deposits, including Fogo A (~4.6 ka, 0.7 km^3 d.r.e.), Fogo 1563 AD (0.14 km^3 d.r.e.), and Furnas 1630 AD (0.65 km^3 d.r.e.). Our results suggest that the magmas evolved primarily via extensive fractional crystallization, with relatively minor assimilation of hydrothermally-altered syenite wallrock prior to the larger volume eruptions. Calculated pre-eruptive magma residence timescales are insensitive to open system processes and appear to correlate with eruptive volume, ranging from 10^1-10^2 years for the smallest volume eruption to 10^3 years for the larger eruptions.

Developmental toxicity of oxidatively degraded quantum dots

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Considerable uncertainty exists about the extent to which engineered nanomaterials may pose an environmental hazard. We examined the toxicity to zebrafish embryos of prototypical engineered nanomaterials before and after simulated environmental "weathering". We employed $CdSe_{core}/ZnS_{shell}$ quantum dots (QDs) functionalized with poly(ethylene) glycol (PEG) of two chain lengths. To examine the environmental weathering of QDs under oxidative conditions, nanoparticles were exposed *in vitro* to an methoxyhydroquinone (MHQ)-driven Fenton's reaction simulating the extracellular chemistry of lignolytic fungi. Zebrafish embryos were exposed to aqueous suspensions of intact and weathered QDs and assessed daily, for 5 days, for sublethal effects and mortality. Exposure to oxidative conditions severely degraded QDs resulting in the release of Cd^{2+} and formation of amorphous Se-containing nanoparticles. Weathered QDs showed higher lethality (LC_{50} = 14 μM Cd equivalents) than intact PEG_{5000}-QDs (LC_{50} = 42 μM Cd equivalents), and both were more toxic than an equivalent amount of cadmium (LC_{50} = 409 μM Cd^{2+}). Many endpoints of toxicity resembled those induced by cadmium; however, other endpoints of toxicity were also observed. Endpoints were similar for weathered QDs and intact PEG_{5000}-QDs. We have eliminated the contributions of Zn^{2+} and (oxidized) PEG ligand to the increased lethality of weathered QDs. Increased lethality of weathered QDs may be due to the selenium nanoparticles formed during exposure to the MHQ-Fenton's reaction.