Effect of reactive gases on crust & ocean compositions on Earth & Mars

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Highly corrosive magmatic gases, rich in $SO_{2(g)}$ and halogens, react with primary minerals and glasses to form soluble salts, secondary oxides and aluminosilicate phases [e.g., 1,2]. These SO_2-rock reactions occur in minutes at high temperature (>500°C) and low pressure; therefore, they disproportionately affect the composition and evolution of the shallow crust, especially in areas with high gas flux; e.g., high temperature degassing and impact processes.

Recent work shows that SO_2-rock reactions produce copious Ca-sulfates, plus Mg- and/or Na-sulfates, and Fe- and (Fe-)Ti-oxides [e.g., 1,2]. Reactions between Cl-gases and rock produce Na, (K- or metal-) chlorides [3], whilst F-rich gases produce Ca-rich salts [4]. Other gas-solid reaction products include aluminosilicate and H-bearing minerals.

On Earth, the salts produced in gas-rock reactions are removed from the crust through dissolution, eventually enriching the oceans in the conservative elements: Na and Cl. The remaining crust will be depleted in Ca, Mg, Na and Fe; producing more aluminous or potassic compositions depending on the initial bulk crust and the extent of reaction.

On Mars, gases derived from magmatic or impact processes likely reacted with rocks to produce abundant Ca, Fe, Mg, (Na) sulfates, Ca, Na, chlorides and/or perchlorates, Fe-O-(H-S) minerals, and amorphous material. Any water likely dissolved and remobilised Ca, Mg, Na, S and Cl. At low water:rock ratios and low pH, Fe is mobilised in waters, but at moderate values it is retained in Fe-O-H-(S) minerals [5]. Gas reactions with common minerals on Mars will mobilise Ca, Mg and Fe providing a novel mechanism to form an alkali-enriched residue in the martian crust that may contribute to some igneous rocks [e.g., rocks described by 6].

DEDICATION: This abstract is dedicated to the late **John R. Holloway**, who loved to visit alkali igneous rocks in the SW USA and who enjoyed thinking beyond Earth. John was a brilliant and creative scientist, and inspiring mentor.

[1] Renggli & King (2018) *Rev. Mineral. Geochem.* 84, in press. [2] Palm et al. (2018) *Rev. Mineral. Geochem.* 84, in review. [3] Ayris et al. (2014) *Geochim. Cosmochim. Ac.* 10.1016/j.gca.2014.08.028. [4] Óskarsson (1980) J. Volc. Geoth. Res. 10.1016/0377-0273(80)909107-9. [5] King & McSween (2005) *JGR-Planets* 10.1029/2005JE002482. [6] Schmidt et al. (2014) *JGR-Planets* 10.1002/2013JE004481.