



Sequential geochemical extractions and mineralogy of Fe-bearing minerals in carbonatized mantle rocks in the Samail Ophiolite, Oman

Severin, Zena¹, Till, Jessica L.¹, Oman Drilling Project Phase 1 Science Party
¹Institute of Earth Sciences, University of Iceland, Reykjavik, IS

Introduction

The Samail ophiolite, Oman, is comprised of intervals of listvenite outcrops between layers of serpentinite zones above the basal thrust zone, atop the metamorphic sole. Near the base of the ophiolite mantle section, some peridotites underwent 100% carbonation from metasomatic introduction of CO₂-bearing fluids <200° C to form listvenites during the time of emplacement 97±29 Ma¹. Listvenites comprise mostly magnesite and/or dolomite, quartz, spinel, and Fe-(hydr)oxides; with carbonates as the sole Mg-minerals and quartz as the only silicate phase.¹ This study uses drill cores samples obtained by the Oman Drilling Project of the International Continental Drilling Project (ICDP). Listvenites from hole BT1B were chemically and petrographically studied to better understand how iron behaves during formation of secondary carbonate minerals. The distribution of iron in carbonate, silicate and oxide phases is quantified by selected chemical dissolution experiments.

Methods

The quantities of iron proportions and Fe-oxide/hydroxide phases based on the sample's mineralogy were investigated through a series of chemical extractions via atomic absorption spectroscopy in addition to optical microscope, SEM/EDS, EPMA/WDS and ICP analysis. Fifteen working half dill core samples from hole BT1B at varying depths were used in the selected sequential extraction procedures developed by Poulton and Canfield, 2005. Performed at the University of Iceland two series of extractions are presented. The first was carried out with a 24-hour (series A) Na-acetate extractant solution at room temperature. The second (series B) was in Na-acetate solution for 48-hours at 50° C. Both series were followed by a HCl (extractable Fe(II) in easily reducible oxides; sodium dithionite (reducible oxides) and an ammonium oxalate: magnetite extractant.³ The accuracy of carbonate associated irons (siderite) was tested by performing the same chemical extractions on a pure and altered siderite sample form Greenland.

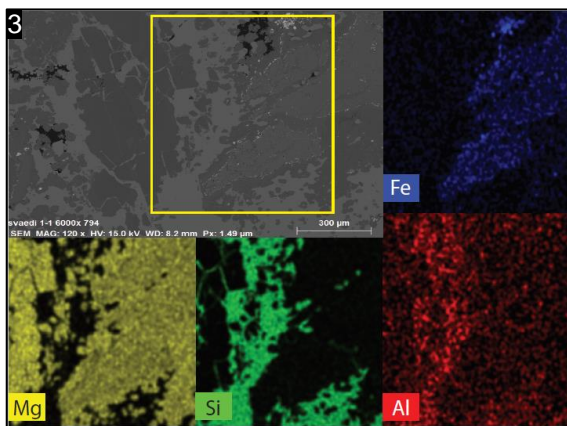


Fig. 3. EDS image and map of sample 15z-01, magnesite and silicate phases

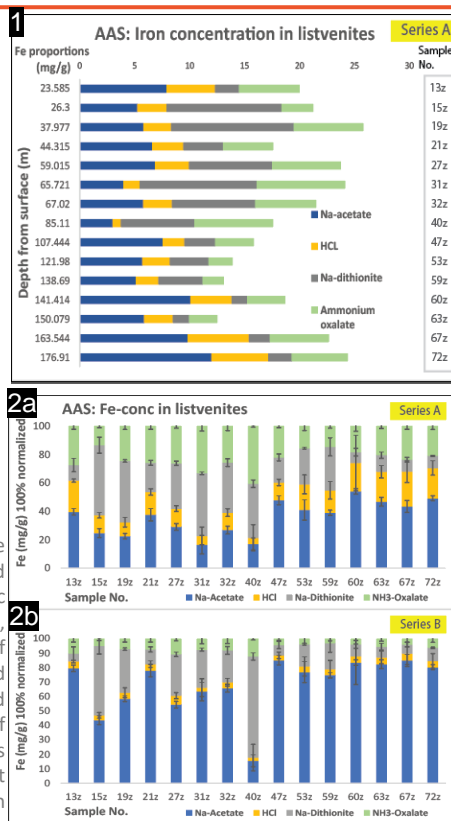


Fig. 1. Atomic absorption spectroscopy results: total Fe extracted Fig. 2. a) & b) Normalized proportions mg/g per extraction relative to 100 mg of powdered sample normalized to 100%. 24hr and 48hr

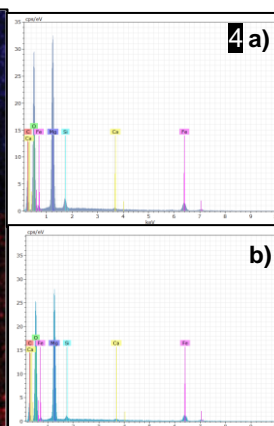


Fig. 4. EDS spectrum of carbonate phases a) sample 27z-02 b) sample 67z-04

Results

- The largest fraction of extractable Fe is associated with carbonate minerals.
- Carbonate associated iron (siderite or ankerite)¹ proportions range from 17-53±2.7% of the total extracted iron in series A and 16-84±4.8% in series B. (Fig.2)
- Total Fe of siderite extracted in Greenland sample was 42%, only slightly lower than the expected 48.2%.
- EMPA data quantified carbonates associated Fe ranging 1.296-10.8±2.27.
- ICP data shows weak correlations of major elements within solution to Fe proportions.

Discussion

- Some magnetite and hematite may have formed from the oxidation of the significant siderite component in solid solution with magnesite.
- Relatively small HCl extraction values do not suggest significant amounts of poorly crystalline Fe-phases or amorphous oxides previously stated by Falk and Kelemen (2015).
- Increased temperature and time in series B may have resulted in an overestimate of carb-Fe.

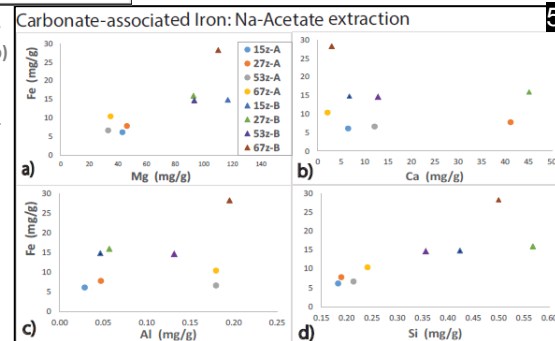


Fig. 5. Bivariate plots of Fe versus major elements in listvenites based on ICP data:

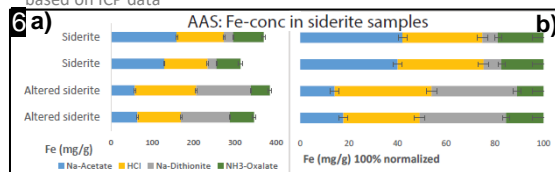


Fig. 5. Total Fe extracted AAS results a) Fe concentration per phase mg/g b) Fe concentration normalized to 100%

References:

- ¹Falk, E. S., & Kelemen, P. B. (2015). Geochemistry and petrology of listvenite in the Samail ophiolite, Sultanate of Oman: Complete carbonation of peridotite during ophiolite emplacement. *Geochimica et Cosmochimica Acta*, 160, 70-90
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- ³Poulton, S. W., & Canfield, D. E. (2005). Development of a sequential extraction procedure for iron: implications for iron partitioning in continentally derived particulates. *Chemical Geology*, 214(3-4), 209-221.