

P 2.7

Sulfur isotopes and trace element analyses of ore and gangue minerals from the Rio Marina Fe-deposit, Elba Island: implications for formation mechanism and fluid sources.

Natalia Karadima¹, Kalin Kouzmanov¹, Andrea Dini², Markus Wälle³, Jorge Spangenberg⁴ & John Poté⁵

¹ Department of Earth Sciences, University of Geneva, Rue de Maraichaire 13, CH-1205 Genève (Natalia-Konstantina.Karadima@etu.unige.ch)

² Istituto di Geoscienze e Georisorse, CNR, Pisa, Italy

³ Institute of Geochemistry and Petrology, ETH Zurich, 8092 Zurich, Switzerland

⁴ Institute of Earth Sciences, University of Lausanne, 1015 Lausanne, Switzerland

⁵ Institut F.-A. Forel, University of Geneva, 10 Route de Suisse, Versoix, Switzerland

Elba Island is located in the Northern Tyrrhenian Sea and is considered to be the innermost outcrop of the Northern Apennines Chain. Since Late Miocene it was affected by post-collisional extension and widespread magmatism of the Tuscan Magmatic Province (8.4-5.9 Ma) which resulted in the emplacement of two acidic plutons, Monte Capanne granitoid and Porto Azzuro monzogranite with ages 6.8Ma and 6-5.4Ma respectively (Bortolotti et al., 2001), and several dyke-laccolith complexes of variable composition. Iron-ore deposits associated with distal hedenbergite-ilvaite skarns are spatially related to the younger magmatic stage (~5.9 Ma, Lippolt et al., 1995) but never in direct contact with the intrusions.

This study is focused on the Rio Marina Fe-deposit which, is one of the six ore deposits on the island. It is located on the Eastern coast of Elba and is hosted in the "Verrucano Formation". Iron ore occurs as massive stratiform to pod-like hematite ± pyrite bodies and/or vein type ore bodies that follow an overall N-S trend. The ore bodies are restricted mainly to the upper 150-250m of a Permo-Triassic schists and along their contact with the overlying Upper Triassic "Calcare Cavernoso", a marble sequence (Bodechtel, 1965). The host mica shists are strongly affected by complex hydrothermal events which make them appear locally as grey-yellowish to green or reddish-violet in color. The main mineral assemblage consists of hematite, adularia, quartz and chlorite, with minor sphalerite, chalcopryrite, galena, rutile, apatite and fluorite.

In order to decipher the complexity of hydrothermal events, sulfur isotope analyses were carried out in parallel to trace element study on the main ore and gangue minerals in the deposit. Sulfur isotope analyses on sulfides (pyrite, sphalerite and chalcopryrite) vary between $\delta^{34}\text{S}$ 9.4 and 4.2 ‰. Large single pyrite crystals (up to 6 cm in diameter) were cut perpendicular to the main crystal face and small samples were collected along core-to-rim profiles in order to study the evolution of trace element and isotopic signature of pyrite with time. Significant decrease in $\delta^{34}\text{S}$ was registered (up to 2.5 ‰), indicating changes in the source fluid signature (Fig. 1a). ICP-MS trace element analyses on the same pyrite aliquots show a clear correlation of specific trace elements (i.e. Co, Cu, Ni, Se) with the decreasing $\delta^{34}\text{S}$ (Fig. 1b), illustrating ore precipitation in an evolving hydrothermal system. Furthermore, electron microprobe and LA-ICP-MS analyses on both ore and gangue minerals reveal complex chemistry of the main hydrothermal products. Chlorite as the main alteration mineral shows an anomalous chemistry and optical properties.

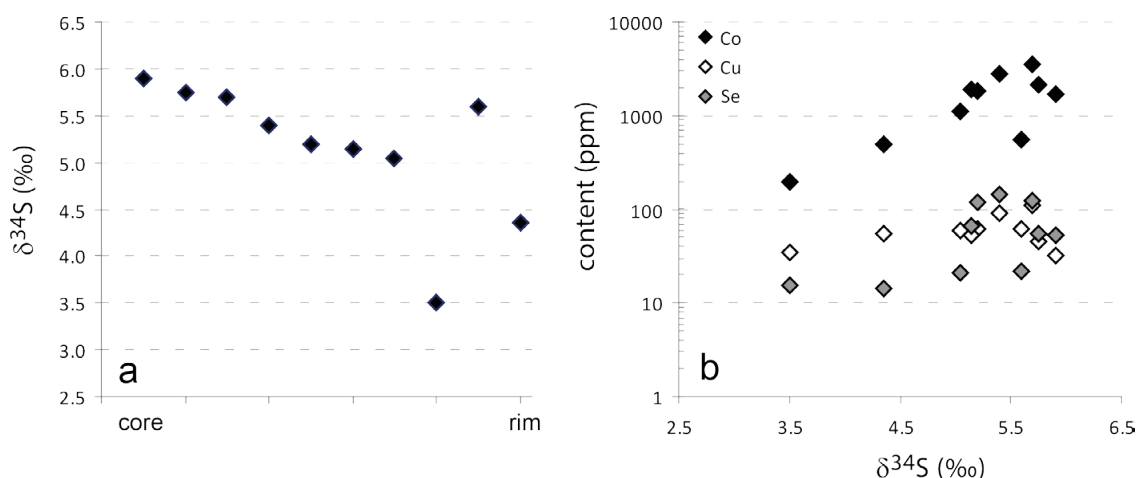


Figure 1. Sulfur isotopes (a) and ICP-MS trace element analyses (b) on a single pyrite crystal along a core-to-rim profile.

Our results illustrate the complex character of the hydrothermal system at Rio Marina where two or more fluid sources were involved in the iron ore-deposition post-dating skarn formation with no direct link with a causative magmatic body.

REFERENCES

- Bodechtel J., 1965: Zur Genese der Eisenerze der Toskana und der Insel Elba. Neues Jahrb. Min. Abhandl., 103:147-162
- Lippolt H.J., Wernicke R.S. & Bähr R. 1995: Paragenetic specularite and adularia (Elba Island): concordant (U+Th)-He and K-Ar ages. Earth Planet Sci. Lett. 132, 43-51
- Bortolotti V., Pandeli E. & Principi G. 2001: The Geology of Elba Island: an historical introduction. Ofioliti, 26 (2a), 79-96

P 2.8**SEM/EDS and TEM/EDS analyses of volcanic particles sampled above the surface of the Erta'Ale lava lake, Danakil depression, Ethiopia, using a remotely-controlled self-closing sampler**

Cédric Botter¹, Bernard Grobéty¹

¹ *Département des Géosciences et FRIMAT, University of Fribourg, Chemin du musée 6, CH-1700 Fribourg*

Gas-to-particle conversion and coalescence of ultrafine aerosol particles are the processes generating nanometric solid secondary volcanic particles within high temperature magmatic emissions. Due to the poor accessibility of most of the degassing lava bodies found in open-vent settings, only particles formed by precipitation within liquid droplets are usually sampled in relatively aged plumes in which magmatic and atmospheric water condensates. The chemical and mineralogical compositions of such polyphasic and hydrated particles are not anymore the ones characterizing the first solids formed at the source.

In January 2015, the level of the permanent lava lake relative to the caldera floor of the Erta'Ale volcano was so high that it permitted the sampling of particles within high temperature magmatic emissions less than two meters above the lake surface. Pristine particles impacted onto different types of sampling substrates within a remotely-controlled self-closing cylinder preventing air and humidity to interact with the aerosol sample during recovery and cooling of the sampler. Manual single-particle analyses using SEM/EDS and TEM/EDS were performed on the samples to investigate the mineralogy, chemistry and morphology of the particles. The high temperature samples were compared with filter samples collected at the rim edge of the lake-hosting pit crater. Automated single-particle analyses using SEM/EDX were performed on the later.

Two different particle populations with different chemistry, mineralogy and particle size distribution occur on the sampling substrates. K and Na sulfate-composed particles having diameters of 100-300 nm of which a part is crystalline K sulfate and the other amorphous Cu-bearing K and Na sulfate are found within a very dense and regularly distributed population of 20-60 nm-sized, sulfur-dominated particles. Differences observed between the high temperature samples and the samples taken on the pit rim include the appearance of chloride and mixed sulfate-chloride particles on the later. Since the high temperature samples lack evidences of droplet impacts, the sulfate/sulfur phases identified in the particles are likely to be solids directly generated by gases within the still unaltered magmatic emissions.