Geochemical-mineralogical investigation of degassing structures caused by recent volcanic hydrothermalism - Case study: La Calcara, Isle of Panarea (Italy)

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Abstract. Mineralogical and geochemical analysis of hydrothermal degassing tubes from Octopus Rock (La Calcara, Panarea, Italy) yielded a hydrothermal influenced dacitic to andesitic volcanic material, building up characteristic sedimentary structures. Marcasite mineralization is a common feature, which developed during periods of higher thermal activity and thus hydrothermal influence in the past. A batch wise genesis of the tubes was proven.

Introduction

The recent active shallow marine hydrothermal system of Panarea, Italy, is characterized by various types of active hydrothermal venting what causes prominent sedimentary structures. These degassing tubes, especially from the diving location La Calcara, are addressed by our investigations. The tubes were sampled during fieldcampaigns of the Scientific Diving Centre at TU Bergakademie Freiberg in 2011 and 2012.

Methods

Geochemical and mineralogical investigations of the degassing tubes were accomplished on macro-scale as well as on microscopic features using optical microscopy (transmitted, polarized and reflected light; Fig. 1) and SEM-EDS measurements. Point counting at stitched thin-section-images was used to evaluate mineral contributions dependant on the relative distance from the tubes centre. Additional information was gained from volcanic glasses by differential thermo analysis (DTA). The volcanic glasses were separated using a stereomicroscope with crossed polarized light and read-out utensils. XRD-analysis of sampled soft-rock material beside Octopus Rock in La Calcara was accomplished.

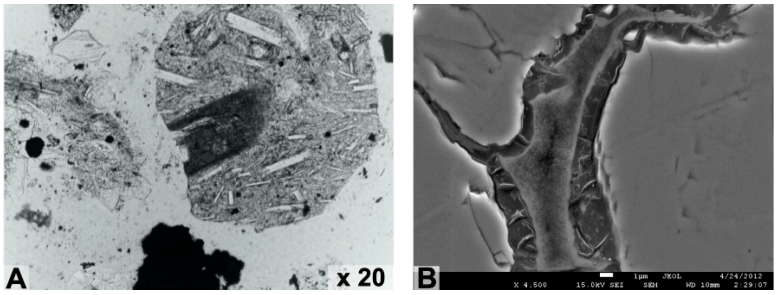

Fig. 1: A: Transmitted light capture of a decomposed mineral (hydrothermal alteration) with a magnification of 20. This outer shape of the minerals is common in the sample material. **B:** FeS_2-mineral with small interstices which contain small (?fecal) pellets (scale: 1 µm).

Sampling and preparation of the softrock material next to Octopus Rock was challenging because of semi-preservable and unstable material (Fig. 2). The relatively hard specimen (mineral precipitates) were collected into PVC cases (4.2L; Fig. 2-A). Alternatively, sampling was realized using a transparent plastic cylinder. It was inserted vertical-

ly into the softrock material over a degassing tube (Fig. 2-B). The aim was to get better knowledge of the structural setting of the tubes and the genetical processes during their formation at the soft sediment environment at La Calcara ("Octopus Rock").

Results

Macro scaled documentation of the degassing tubes revealed mainly appr. 1.5 cm wide and 70° to 110° inclined tube openings. Thin section analysis shows that the main composition of the tubes varies between the volcanites dacite (quartz, alkali feldspars) and andesite (plagioclase, nepheline). The occurrence of decomposed minerals is abundant. The influence of hydrothermal alteration is clearly witnessed and mineral precipitates of various types are a common feature. Smectite and Alunite (occurs in form of Svanberigite) were proven through XRD-analysis and confirm the occurrence of basaltic original material, which was transformed into a softrock material: smectite can be an alteration product of basaltic ash (RÖSLER, 1980). Decomposed feldspar accumulations have a specific element contribution. In outer areas of the accumulations, the composition is similar to an alkali-feldspar and in inner area plagioclase-like. This might be a result of alteration processes, which affected at first outer areas of the feldspar accumulations causing a depletion of Ca and an enrichment of K in the minerals.

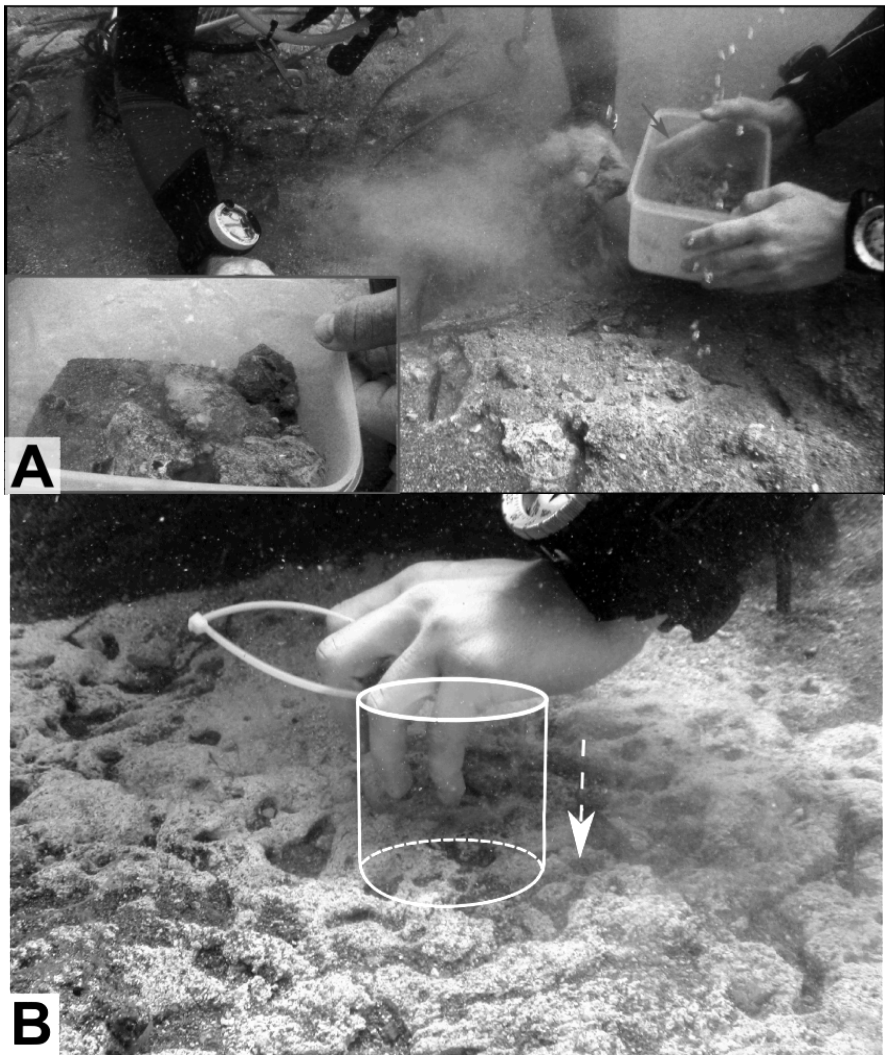

Fig. 2: Two tested sampling methods in La Calcara. **A:** Sampling of softrock material with a PVC-Box (4.2 L). The material decomposed under air pressure. Degassing structures stay stable under water (small picture in frame).**B:** A transparent cylinder was vertically inserted into the softrock underground to sample degassing structures (redrawn schematically with white lines). After sampling the opening was covered with a small board.

Sulphide ore minerals could be identified as marcasite (FeS_2), being common in La Calcara. Pyrite was not proven. The marcasite minerals are overgrown with other mineral phases like feldspar, biotite or pyroxene. Most of the marcasite minerals have a brown seam probably due to alteration processes. A batch wise genesis of marcasite minerals took place (cf. STANULLA et al., 2012). This can be explained by a sudden event with higher thermal activity accompanied by higher occurrence of gas bubbles and water flow. This causes the development of a degassing tube during a sudden temperature and degassing high (Fig. 3).

Measurement of volcanic glasses from Area 26 with DTA showed two different environment conditions: juvenile glasses and altered glasses. This enforces the thesis of batch-wise genetical processes.

Near Octopus Rock two different types of altered basaltic tuffs (Figure 4, A and B) were investigated. The first material (A) has a dark grey to grey color and a grain size from medium clay to silt. The tubes in this material are mainly small but relatively good preserved. The second material (B) is made up of clay to silt with a bright gray color and mainly good preserved degassing tubes. Octopus Rock itself is a small elevation made up of a consistent dacitic rock. The measured temperatures (Fig. 4) at Octopus Rock are shown in the detailed map.

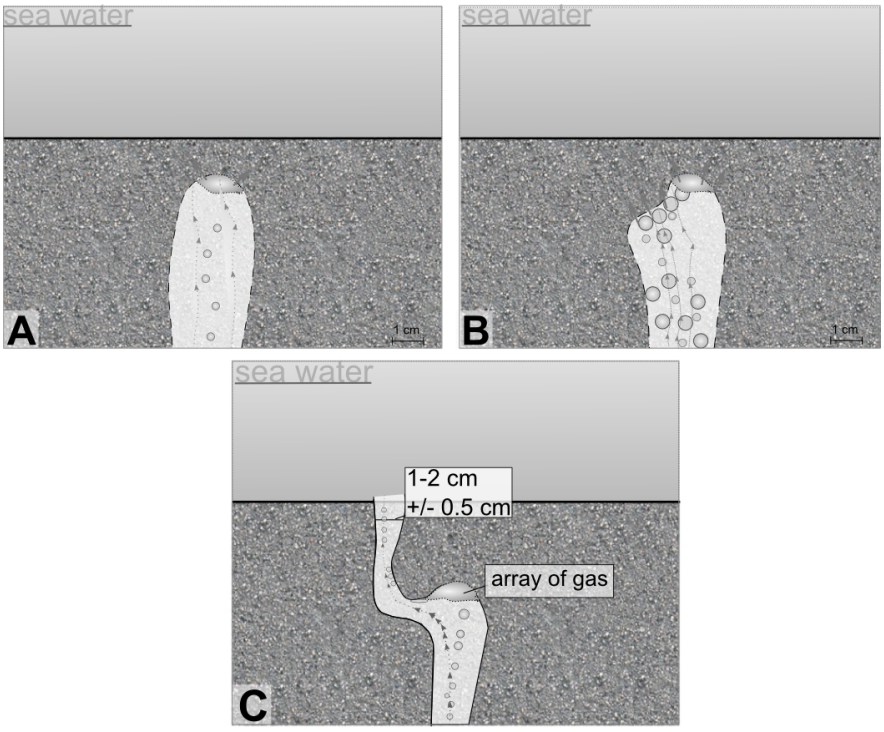

Fig. 3: Model of the systematic step by step evolution of the degassing structures at Octopus Rock (La Calcara). Grey bubbles mark hydrothermal gas emission. Arrows in the tube mark water emanation (cf. STANULLA, 2012). In picture C) a tube is shown as being documented here.

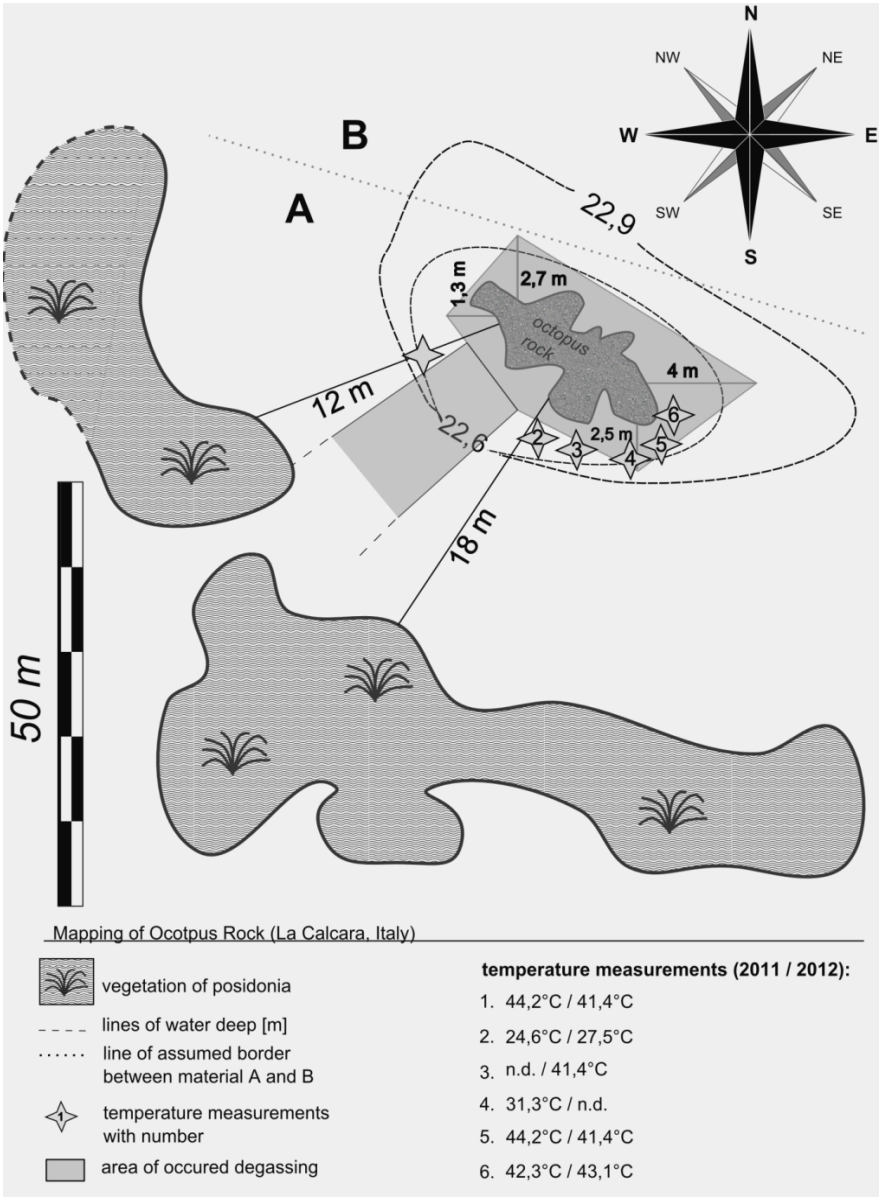

Fig. 4: Map of Octopus Rock with the morphological shape of Octopus Rock, the recognized softrock materials A and B, the temperature measurements, the distance to the posidonia vegetation, lines of water depth and the area where degassing occurred. The dark grey lines mark the distance between Octopus Rock and vegetation of posidonia. At Octopus Rock itself no active degassing was documented.

Compared to other diving locations in Panarea such as Bottaro West, Hot Lake, Point 21, Area 26, Black Point or Basiluzzo, La Calcara has different types of degassing structures. They are genetically influenced by gas- and water discharge and connected constructive processes. Unconsolidated cones and partly consolidated tubes are common. Mineral precipitates of sulfur-, iron- and other, still unidentified, compounds and substances occur (cf. STANULLA, 2012) in an altered softrock material.

In the future, the continuation of sampling in Area 26 (large area lateral sampling of volcanic glasses) and in La Calcara especially at Octopus Rock (improvement of sampling methods of softrock material) should be completed.

A detailed investigation with a microprobe of polished thin sections which contain a radial cut through a degassing tube should be targeted. Gaining information about oxidizing or reducing genetical conditions should be one main point of interest to evaluate the influences of microorganisms in hydrothermal systems with respect to sedimentary degassing structures.

References

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