Submarine emissions on the seafloor: from cold seeps to hot vents

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Abstract

The main types of submarine geological emissions are classified as cold seeps (hydrocarbons and brines) and hot vents. These processes result in the emission of geological fluids: brine, gases (mainly hydrocarbons), sediments and rocks. Submarine emissions are associated with an intensive geological, geochemical, thermal and biological activity (Judd and Hovland, 2007), and constitute a key process in the dynamics of the global cycles of the planet Earth. These systems play a major role in the exchange of matter and energy between the Geosphere and Hydrosphere, contributing to the greenhouse gases and affecting the ocean chemistry (Dimitrov, 2002; Alt, 2003). They also control the evolution of continental margins and oceanic basins (Paull y Dillon, 2001), and can produce the formation of significant and strategic mineralizations, as well as focus the development of specific habitats (Boetius et al., 2000) and provide an insight of deeper parts of the crust.

Cold-seep systems are usually rich in hydrocarbons and have been described throughout the world in both rifted and convergent margins. They can display a wide variety of morphological features, structures and related deposits, which include diapirs, mud volcanoes, brine pools, pockmarks, carbonate mounds and accumulations of authigenic precipitates. The most spectacular structures are mud volcanoes which are built by rapid extrusion of fluid and sediments from an overpressure unit, controlled by tectonics pathways (Kopf, 2002). Lithification by bacterial oxidation of hydrocarbons, mainly methane, are frequents in these systems. Crusts, chimneys and other aggregates of authigenic carbonates are generated as well as nodules and crusts of Fe-Mn, also linked to this oxidation, and patches of sulphides formed by sulfate-reducing bacteria. Furthermore, there is an heterogeneity of habitats and biological communities associated to cold-seeps with highlighting chemosynthetic species (e.g., Siboglinum, Solemya, Bathymodiolus, etc..) and aggregations of cold water corals and sponges.

Hot vents systems have been described on convergent margins, accretion rift axes, transform faults and hotspot volcanic chains, where fluid emissions can be formed in connection with magmas and/or hydrothermal circulation systems ranging from high temperature (400 ºC), relative to magmatic and hydrotermal processes, to relatively low ($<$40 °C), in relation to serpentinization processes of the oceanic crust or subcortical mantle and generating abiogenic methane. Fluids associated to magmas are primarily gaseous: CO_2, H_2O, CO, SO_2, S_2, H_2S and occasionally methane, especially in processes of peridotitic serpentinization. Hydrothermal activity results of the water warming in contact with magma and hot volcanic rocks, leaching large amounts of chemical elements (e.g., Fe, Mn, Ni, Cu) traversing rocks towards the seafloor (Scott, 1997). These systems have mineral deposits, as massive sulphides, metalliferous muds, Mn crusts, magmatic sulfides and carbonates derived from abiogenic methane. Hydrothermal systems occur where seawater percolates through fissures and fractures in sediments and rocks at different depths and favor the development of associate habitats characterized by high productivity, high degree of endemicity of species and high structural complexity (German et al., 2011).

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