

Magma ascent and degassing process of Miyakejima 2000 eruption: constraints from glass inclusions and volcanic gases

G. SAITO, K. UTO, K. KAZAHAYA AND H. SHINOHARA

Geological Survey of Japan, National Institute of Advanced Industrial Science and Technology, Japan, saito-g@aist.go.jp

Among a series of 2000 Miyakejima volcanic activity, a largest phreatomagmatic eruption occurred at the summit on August 18. Major eruptions ceased at the end of August, but intense and continuous degassing activity from the summit started. Volatile analyses of glass inclusions in plagioclase and olivine in the essential products ejected by the 18 August eruption were carried out in order to investigate the eruption and gas emission process.

Major element compositions of glass inclusions are generally similar to those of groundmass, indicating the entrapment just before the eruption. Volatile analyses of glass inclusions indicate that melt in the magma had volatile contents of 0.9-1.9 wt.% H₂O, <0.011wt.% CO₂, 0.04-0.17wt.% S and 0.06-0.1wt.% Cl. Gas saturation pressure of the inclusions was calculated to 20-60 MPa. The low gas saturation pressures and the variation in H₂O and S contents indicate magma degassing at a shallow depth of 1-3 km. A ratio of H₂O and S content of glass inclusions is similar to that of volcanic gas, indicating that the 18 August magma is the source of the gas emission. The initial volatile content of the magma was estimated to 1.9 wt.% H₂O, 0.1 wt.% CO₂, 0.12-0.17 wt.% S and 0.06-0.07 wt.% Cl based on the volatile content of the inclusions and the volcanic gas composition. Gas saturation pressure of the magma with the initial H₂O and CO₂ contents is calculated to be 250 MPa, corresponding to 10 km depth. Using the initial volatile content of the magma, bulk density and bubble volume of the magma were calculated to 2.6 g/cm³ and 0 % at 10 km depth, 2.5 g/cm³ and 3 % at 3 km depth and 1.7 g/cm³ and 30 % at 1 km depth. Comparing these bulk densities with density structure of crust, magma ascent and degassing process can be interpreted as follows; just before the 18 August eruption, the magma ascended from 10 km depth up to ~3 km depth by buoyant force because the magma has lower bulk density than that of the crust (2.7 g/cm³). Exsolution of CO₂-rich gas from the melt caused decrease in the bulk density. The magma might stay at 3-5 km depth to form a magma pocket or a shallow magma chamber because of neutral buoyancy of the magma. It could ascend again by the stoping mechanism (Uto et al. 2001; Geshi et al. 2002). At less than 3 km depth, exsolution of H₂O and S started and the bubble volume drastically increased up to ~30 % at 1 km depth. This highly vesiculated magma was contact with ground water to cause the large phreatomagmatic eruption.

Type of organic matter in sediments from ODP Leg 190 Site 1175, 1176, and 1178, controlling gas hydrate formation in Nankai Trough, Japan

¹HIROYUKI SAITO AND ²NORIYUKI SUZUKI

^{1,2}Division of Earth and Planetary Sciences, Graduate school of Science, Hokkaido University (saito@ep.sci.hokudai.ac.jp, suzu@ep.sci.hokudai.ac.jp)

Introduction

Bottom simulating reflectors (BSR) are widely distributed in accretionary prism of Nankai Trough, showing the presence of enormous amount of gas hydrate. In addition to equilibrium condition of temperature and pressure for the formation of gas hydrate, the significant presence of source rock for generation of biogenic methane can be another necessary condition. However, our knowledge on the source rock of methane for gas hydrate formation is poor. The sediment samples and various data sets from ODP Leg 190 Site 1175, 1176, and 1178 are useful to establish new concept of "source rock" for methane gas hydrate formation.

Results and Discussion

Temperature measurements and Cl concentrations in pore water of ODP Leg 190 Sites 1175, 1176, and 1178 indirectly show that gas hydrate is present only in Site 1178. Any significant differences of subsurface temperature and pressure in all the Sites were not noted. Total organic carbon (TOC), total nitrogen (TN), and inorganic carbon (C_{inorg}) concentrations, n-alkanes, n-alkanoic acids, and n-alcohols in sediments from Site 1175, 1176, and 1178 are analyzed to investigate the role of sedimentary organic matter for the formation of gas hydrate (Fig. 1). The followings are clarified in the present paper. (1) Sediments rich in terrigenous organic matter are generally characterized by comparatively high TOC concentrations in Nankai Trough. (2) Gas hydrate is associated with sediments rich in terrigenous organic matter.

Organic matter derived from terrestrial higher plants is generally rich in oxygen and can generate much CO₂ in the early stage of diagenesis. This type of CO₂ can be a major precursor of methane that is generated by methanogens.

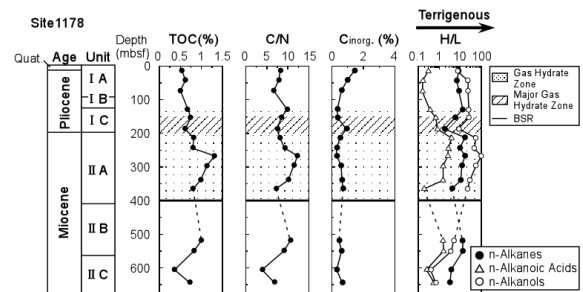


Fig. 1. Down-core profiles of TOC and C_{inorg} concentrations, C/N ratios, and terrigenous to aquatic lipid ratios in sediments from Site 1178.