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Development of an electric control gas-tight sampler for seafloor hydrothermal fluids*

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Abstract: Submarine hydrothermal vents occur over a wide depth range from a few meters to several thousands of meters. Most existing hydrothermal fluid samplers are focused on deep-sea environments and are not suited for collecting shallow-water fluids. In this study, a new gas-tight sampler which can be easily deployed by both submersibles and scuba divers to collect fluid samples from both deep-sea and shallow-water hydrothermal vents is presented. The proposed sampler uses an electric control sampling valve for fluid collection and a system to measure and display the temperature of the hydrothermal fluid while sampling. It is capable of working in manual mode to be controlled via external signals, or in automatic mode to collect a fluid sample according to the temperature. The master-slave architecture of the electronic system makes the sampler flexible in meeting many different deployment requirements. The performance of the sampler has been demonstrated by preliminary field tests at a shallow-water hydrothermal vent site.

Key words: Hydrothermal fluid, Electric control, Sampler, Deep sea, Gas-tight
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1 Introduction

It is well known that seafloor hydrothermal activity plays an important role in regulating the exchange of heat and mass between seawater and the oceanic crust. Deep-sea hydrothermal vents and exotic organisms were first discovered in 1977 at Galapagos Rift, a spur of the East Pacific Rise (Corliss *et al.*, 1979). Since then, many more deep-sea hydrothermal sites have been found along the mid-ocean ridges and in back-arc basin settings (Bowers *et al.*, 1988; Campbell *et al.*, 1988; Fouquet *et al.*, 1991; Gamo *et al.*, 2001). These sites are typically located at water depths of over 2000 m and are spectacularly featured with so-called "black smokers", which emit high-temperature hydrothermal fluids with black clouds of metal sulphide particles. Most studies of seafloor hydrothermal activity have focused on these hydrothermal sites. However, submarine hydrothermal activity is not confined to deep-water environments. Recently, a number of shallow-water hydrothermal vents have been found and studied at the flanks of volcanic islands and on the tops of seamounts (Pichler *et al.*, 1999; Cardigos *et al.*, 2005; Chen *et al.*, 2005a; 2005b). Shallow-water hydrothermal vent fluids generally present transitional chemical characteristics between deep-sea and subaerial vents. They provide an exceptional opportunity to study the differences and similarities between submarine and sub-aerial venting, and provide a more comprehensive understanding of the heat and mass exchange between seawater and the oceanic crust (Pichler *et al.*, 1999).

Hydrothermal fluid samplers are one of the most important engineering tools for the study of hydrothermal activity. To meet the requirements of scientific

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