



Hydrogeochemical tools for monitoring active volcanoes: Applications to El Chichón volcano, México.

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In 1982, a series of eruptions resulted in the worst disaster linked with volcanic activity in México. The characteristics of the phenomena together with a lack of prevention measures resulted in approximately 2000 deaths. An important aspect to prevent disasters is a thorough knowledge and monitoring of the potentially destructive natural phenomena. Monitoring the activity of dormant or active volcanoes by various methods is thus a key measure to estimate the hazard and design adequate risk reduction measures. Despite of the 1982 volcanic disaster, until only a few years, hydrogeochemical monitoring was the only regular surveillance of El Chichón post-eruptive activity. The first samples of the crater-lake water were collected by Casadevall et al. in 1983. Since 1985, a systematic sampling and chemical analyses program has been carried out by the Geophysics Institute in collaboration with local authorities from the State of Chiapas. Chemical analyses of main ions and Rare Earth elements (REE) are performed in the Laboratorio de Química Analítica and Laboratorio ICP-MS of the Instituto de Geofísica, UNAM. Results are interpreted considering the physico-chemical changes that may be recognized as precursors of volcanic activity. The problem is difficult because at least two main water reservoirs feed the crater lake; besides, dissolution of acid volcanic gases, water-rock interactions and geochemical processes among dissolved species have resulted in a complex chemical behavior of the lake-water along the years. The calculated degree of neutralization, pH values, and chloride and sulfate concentrations of samples taken at different dates result in a classification of the volcano as active or inactive according to the method developed by Varekamp. A pH of 0.5, very high conductivity and a temperature of about 50°C characterized the first years following the eruptions. An overall decrease on the temperature and ionic concentrations, along with a less acid pH (around 2.5) have been measured during the last 20 years. However, important changes on the individual concentrations of the main ions have also been observed within this time. These changes show the dynamics of the lake and the relative influence of the water sources, volcanic gases and geochemical processes on the water samples. On the other hand, the lack of REE elements concentration variations reflects some volcanic stability in the period 2006 to 2008. These observations have led to the identification of specific precursory hydrogeochemical parameters, that contribute to the dynamic hazard assessment of El Chichón.