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Is boron a hydrogeochemical indicator of the ongoing lava dome eruption at Popocatepetl volcano?

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On 21 December 1994, Popocatépetl volcano reawakened after about 70 years of dormancy with a series of phreatic explosions. Considering that the eruptive history of Popocatépetl volcano indicates that past activity has included major Plinian phases, great concern raised about the possible outcomes of that activity. This prompted the implementation of seismic, geodetic and visual monitoring devices, and a hydrogeochemical follow-up of water samples collected at different sites near the volcano. On March 1996 the first lava dome of a series of at least 40 distinct episodes of dome emplacement and further destruction that continue to the present was confirmed growing on the crater floor. A main feature of this succession is that it has developed as a process showing regimes of high and low emplacement and lava production rates alternating around a long term mean. Another feature of the ongoing eruption is the spatial distribution of the volcano-tectonic (VT) seismicity which has concentrated in two regions since the earliest stages of the activity, one below the crater, and other beneath the SE sector of the volcano. The latter activity is probably related to predominately normal faulting in that sector, associated to the NE–SW direction of maximum distention stress that may have caused sector collapses in the past. Here, we focus on the role of boron as one of the key hydrogeochemical indicators of the volcanic activity level. Since 1996, water samples have been systematically collected from 6 springs and one well located at distances between 14 and 35 km from the volcano crater. All sites are located in the southern sector of Popocatépetl, since no permanent springs could be found on the northern sector. Routine chemical analyses include spectrophotometrical determination of boron concentration. The analysis of the dome emplacement series and boron concentrations reveals that higher concentrations of boron in spring waters occur mostly during the periods of low dome emplacement and lava production rates. This may be interpreted as a reduced diffusion of volcanic gases into the crustal rocks surrounding the volcano in periods of open conduit activity. In addition, the springs located in the region of higher volcano-tectonic activity, in the SE sector of the volcano show the highest boron concentrations, suggesting increased volcanic gas transport in the fractured crust of that sector. In conclusion, boron dissolved in spring waters is a relevant indicator of the level of volcanic activity even in samples collected in populated areas at considerable distances of the active crater.