Earthquake Occurrence as a Tracer of Magmatic Activity under the Earth's Surface

Aleš ŠPIČÁK, Václav HANUŠ and Jiří VANĚK

Geophysical Institute of Academy of Sciences of the Czech Republic, Boční II/1401, 141 31 Praha 4, Czech Republic

The results of detailed investigation into the geometry of distribution of earthquakes around and below the volcanoes Korovin, Cleveland, Makushin, Yake-Dake, Oshima, Lewotobi, Fuego, Sangay, Nisyros and Montagne Pelée at convergent plate margins are presented. The ISC hypocentral determinations for the period 1964-99, based on data of global seismic network and relocated by Engdahl, van der Hilst and Buland, have been used.

The aim of this study has been to contribute to the solution of the problem of location of source regions of primary magma for calc-alkaline volcanoes spatially and genetically related to the process of subduction. Several specific features of seismicity pattern were revealed in this context: (i) A clear occurrence of the intermediate-depth aseismic gap in the Wadati-Benioff zone below all investigated active volcanoes. We interpret this part of the subducted slab, which does not contain any teleseismically recorded earthquake with magnitude greater than 4.0, as a partially melted domain of oceanic lithosphere and as a possible source of primary magma for calc-alkaline volcanoes. (ii) A set of earthquakes in the shape of a seismically active column seems to exists in the continental wedge below volcanoes Korovin, Makushin and Sangay. The seismically active columns probably reach from the Earth surface down to the aseismic gap in the Wadati-Benioff zone. This points to the possibility that the upper mantle overlying the subducted slab does not contain large melted domains, displays an intense fracturing and is not likely to represent the site of magma generation. (iii) In the continental wedge below the volcanoes Cleveland, Fuego, Nisyros, Yake-Dake, Oshima and Lewotobi, shallow seismicity occurs down to the depth of 50 km. The domain without any earthquakes between the shallow seismically active column and the aseismic gap in the Wadati-Benioff zone in the depth range of 50–100 km does not exclude the melting of the mantle also above the slab. (iv) Any earthquake does not exist in the lithospheric wedge below the volcano Mount Pelée. The source of primary magma could be located in the subducted slab as well as in the overlying mantle wedge. (v) Frequent aftershock sequences accompanying stronger earthquakes in the seismically active columns indicate high fracturing of the wedge below active volcanoes. (vi) The elongated shape of clusters of epicentres of earthquakes of seismically active columns, as well as stable parameters of the available fault plane solutions, seem to reflect the existence of dominant deeply rooted fracture zones below volcanoes. These facts also favour the location of primary magma in the subducting slab rather than in the overlying wedge.

We suppose that melts advancing from the slab toward the Earth surface may trigger the observed earthquakes in the continental wedge that is critically pre-stressed by the process of subduction. However, for definitive conclusions it will be necessary to explain the occurrence of earthquake clusters below some volcanoes and the lack of seismicity below others, taking into account the uncertainty of focal depth determination from global seismological data in some regions.

Mineralogical Diversity of Felsic Rocks at Contacts with Eclogites in the Orlica–Śnieżnik Dome, West Sudetes

Wojciech STAWIKOWSKI[1] and Diether RHEDE[2]

[1] Institute of Geology, Adam Mickiewicz University, ul. Maków Polnych 16 61-686 Poznań, Poland

[2] GeoforschungZentrum Potsdam, Telegrafenberg D-14473 Potsdam, Germany

The relationships between numerous small bodies of (U)HP eclogites and their country rocks in the Lądek–Śnieżnik metamorphic unit (LSMU), the eastern part of Orlica–Śnieżnik Dome, West Sudetes, are still unclear. Recent hypotheses assume either joint (U)HP history of all these rocks, or tectonic emplacement of eclogites during the post-UHP event. The problem is enhanced by the complicated structure of the LSMU and strong diversity of the eclogites with respect to their protoliths and peak metamorphic conditions.

In the Śnieżnik unit (SU) of the LSMU, eclogite-gneiss contact zones were studied at two localities: near Nowa Morawa and Bielice. The SU eclogites have calc-alkaline affinity and experienced conditions of T = 660–780 °C, P >29 kbar (Bakun-Czubarow, 1998). The ages of 341 ± 7 and 329 ± 6 Ma for UHP