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The Southern Volcanic Zone of Chile: Calculations of Holocene and Pleistocene volcano volumina on the basis of morphologic data and relations between mass distribution and subduction parameters

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The Southern Volcanic Zone of Chile (SVZ) comprises a 1400 km long chain of more than 60 Andean volcanos and volcanic centers between 33°S and 46°S. The volcanic edifices include individual cinder cones of few km diameter to huge stratovolcanoes which rise up to 2000 m from their basement. Also, the clustering of volcanoes and of volcano edifice volumes, the position of the volcanic arc and the maximum distance between arc and backarc volcanoes varies greatly along the SVZ.

In the first part of this contribution we present volume calculations for all of the documented volcanic edifices of the SVZ. The calculation was performed with a Digital Elevation Model based on topographic data of the Shuttle Radar Topography Mission (SRTM). The calculation is straightforward for isolated and morphologically well defined stratovolcanoes such as Lanin, Villarrica or Tromen. Uncertainties increase where volcanic edifices rest upon, or mold into, pre-existing rugged terrains of non-volcanic nature such as the Central Cordillera, in the case of calderas and complex multi-phase eruptive centers, where boundaries are obscured, and in the case of eroded or collapsed edifices. We therefore offer a quality index to the calculated volumes, a maximum and minimum estimation and a discussion of error sources and ranges.

This volume calculation is a first step for a composite mass budget of the in- and output of the Chilean Subduction Zone. The other necessary components of the output flux (erupted tephra volumes and rates of permanent degassing) are being adressed by parallel campaigns of the SFB574. The quantification of the magmatic output is therefore a first step towards understanding the subduction system of an arc segment, providing insights into volatile cycles, magmatic evolution and hazards.

The second part tries to link the described spatial clustering of volcanoes and the volume distribution of their edifices to the along-strike segmentation of this subduction zone in terms of topography, basin distribution and subduction geometry. In particular, changes in the depth of the slab beneath the arc, the height of the melting column, and the existence of fracture zones of the subducting Nazca Plate could hold clues to the melting processes, while the distribution of old, deep-reaching fault zones in the upper plate could dominate the melt pathways. A model for a segmentation of the SVZ is discussed.

As similar considerations were undertaken at the Central American Volcanic Arc (CAVA), a comparison between the two subduction systems has been drawn, revealing several striking differences. At the CAVA, the average edifice volume is relatively small (50km3) at a high volcano density (one volcano per 13 km of arc length), whereas at the SVZ the average volume of > 200 km3 per volcano is allotted to a much smaller volcano density (1 per 25 km arc length). Individual edifice volumes reach much higher values at the SVZ - the largest being the Cordon Caulle-Puyehue-Mencheca complex with a volume > 1200 km3 - than at the CAVA where Irazu displays the maximum of 242 km3.