^{3}HE EVIDENCE FOR A WIDE ZONE OF ACTIVE MANTLE MELTING BENEATH THE CENTRAL ANDES.

Leonore Hoke(1), David R. Hilton(2), Simon H. Lamb(1),
Konrad Hammerschmidt(2), Hans Friedrichsen (2)

(1) Department of Earth Sciences, University of Oxford, U.K.;
(2) FR Geochemie, Freie Universität Berlin, Germany.

RESUMEN

Una exploración regional de relaciones $^3He/^4He$ medidas en gases y aguas emitidos en áreas geotermales y aguas minerales de origen volcánico en los Andes Centrales, sugiere la presencia de una zona de fusión activa del manto de 350 km de ancho. La producción de fundidos bajo el arco volcánico probablemente se encuentra controlada por fundentes hídricos por encima de la zona de subducción. Sin embargo, bajo el Altiplano y la Cordillera Oriental, la fusión del manto es probablemente debida al adelgazamiento del manto litoférico acompañado con la resurgencia de astenosfera relativamente caliente.

KEY WORDS: Helium isotopes, Central Andes, geothermal areas, active mantle melting.

INTRODUCTION AND GEOLOGICAL SETTING

We report results of a comprehensive survey of $^3He/^4He$ ratios measured in gasses emitted in volcanic sulfataras, geothermal and mineral water areas of the Central Andes of Northern Chile and Bolivia between the latitudes 16°S and 23°S. Samples were collected from the active volcanic arc (Western Cordillera) and along several west to east transects across the high plateau region (Altiplano) into the Eastern Cordillera. The Andes are at their widest within this area (900km), and are unusual in that the Altiplano is underlain by ~70km of continental crust (Cahill & Isacks, 1992), comparable in thickness only to the Tibetan Plateau.

RESULTS

The highest $^3He/^4He$ ratios (R) are associated with active arc volcanoes along the western side of the Altiplano, and approach ratios found at other convergent margins in the circum - Pacific region. For example, Volcan Isluga and Irruputuncu have R/R_A ratios (R_A = air $^3He/^4He$) of 5.52 and 4.96 respectively. Surprisingly, a significant ^3He component ($R/R_A>1$) is also present in mineral and geothermal fluids sampled in the Altiplano and in the Eastern Cordillera - up to distances ~250km east of the active arc and more than 300km above the subducting slab (Cahill & Isacks, 1992). This wide zone of ^3He anomalies is delineated both to the east and to the west by low $^3He/^4He$ ratios ($\leq 0.1R_A$) typical of radiogenic helium production in the crust. All helium ratios were corrected for any air contamination. Furthermore, consideration of the regional ground water regime shows that the wide zone of elevated

$^3He/^4He$ values is unlikely to be caused by lateral transport of ^3He away from the active volcanic arc. In addition there is no evidence for significant sources of ^3He in the crust.

CONCLUSION

It is concluded, therefore, that the high $^3He/^4He$ ratios reflect degassing of volatiles from mantle derived magmas emplaced over a wide area of crust as a result of mantle melting. The radiogenic $^3He/^4He$ ratios on either side of this zone delineate a 350km wide zone of active mantle melting, where the subducting slab is at depths of 100 to 350km. In the west, underneath the active volcanic arc, mantle melt production is probably largely controlled by hydrous fluxing above the subduction zone. However, further east, underneath the Altiplano and Eastern Cordillera mantle melting may be due to thinning of the lithospheric mantle, concomitant with upwelling of relatively hot asthensphere.

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