ADVANCES IN GEOTHERMAL RESEARCH IN CHILE

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RESUMEN: Los geoindicadores Na, K, Mg and Ca indican un mayor grado de equilibrio fluido-roca en áreas termales del Norte de Chile que en las del Centro-Sur. Por otra parte, se presentan resultados de la producción radiogénica de calor y de la estructura termal en Chile Central, y su relación con la derivación magmática de granitoides.

KEY WORDS: Chile: Mature/Immature Fluids; Heat Production; Thermal Structure of the Crust.

FLUID-ROCK EQUILIBRIUM IN GEOTHERMAL AREAS

Evaluation of fluid-rock equilibrium in 33 geothermal areas and in the Santiago Basin was carried out by means of the relative Na, K, Mg and Ca contents of waters, and following the method established by Giggenbach (1988). In northern Chile only in two of eight geothermal areas fluids have attained a partial or a full equilibrium with both K-Na and K-Mg mineral systems; a partial equilibrium is also indicated for seven of twenty hot springs waters in central-south Chile (Table 1). Other geothermal areas correspond to immature waters which are generally unsuitable for the evaluation of K/Na and K/Mg equilibrium temperature; in these cases also CO_2-fugacities cannot be obtained.

TABLE 1. Full equilibrium or partial equilibrium temperatures in geothermal areas of Chile as indicated by the K/Mg and K/Na geothermometers.

Area	Latitude Longitude	T(K/Mg) (°C)	T(K/Na) (°C)
Northern Chile			
Puchuldiza	19°08'S 68°58'W	135-195	192-235
El Tatio (springs)	22°20'S 68°01'W	145-245	180-250

Area	Latitude Longitude	T(K/Mg) (°C)	T(K/Na) (°C)
El Tatio (wells)	22°20'S 68°01'S	165-285	165-285
Central-South Chile			
Apoquindo	33°25'S 70°25'W	80	140
Baños de Colina	33°48'S 70°00'W	120	180
Baños Morales	33°50'S 70°03'W	100	140
Vegas del Flaco	34°57'S 70°28'S	150	245
San Pedro	35°08'S 70°27'W	195	245
Campanario	35°56'S 70°33'W	125	195
Pemehue	38°03'S 71°44'W	115	180

Correlation between molecular Cl/B ratio and Na-K-Ca temperature (Youngman, 1984) is generally consistent with indications of fluid-rock equilibrium in different aquifers of El Tatio. Isotopic analysis of El Tatio waters and results from magnetotelluric soundings in the area -studies carried out by other workers- have been also used to reexamine the length of fluids circulation path by considering the *transparency* of magma (Lachenbruch and Sass, 1977) through hydrothermal convection; the actual distance travelled by the water may be estimated to be 20 Km, at a rate of about 1.3 Km/year.

Chillán (36°57'S; 71°33'W) and Río Blanco (38°35'S; 71°42'W) plot as immature waters; these are acid sulphate waters characterized by high temperatures at depth (170°C-240°C). In the Santiago Basin -in areas at about 33°20'S; 70°50'W- evaluation of fluid-rock equilibrium indicates that waters are immature; if K/Mg temperatures were still valid, deeper equilibrium temperatures may be of about 80°C.

HEAT PRODUCTION AND THERMAL STRUCTURE OF THE CRUST

The radiogenic surface heat production has been preliminary determined in the three tectonic units of Central Chile (33°S), ranging from the Coastal Range to the Andes Cordillera (Table 2).

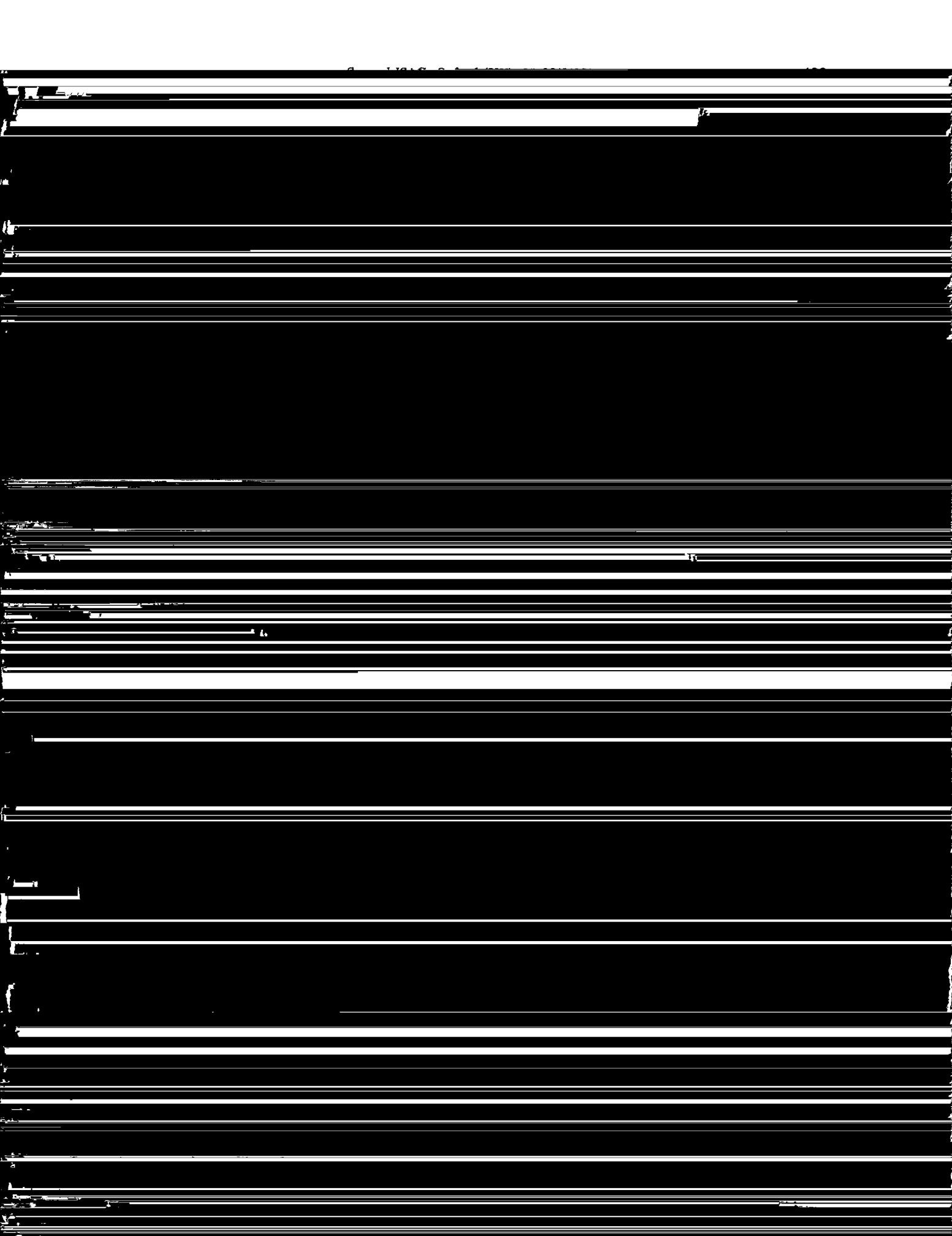

TABLE 3. Erosion rates - Central Chile batholiths.

	(from Heat Production) ($cm/10^3y$)	(from Scholl et al. (1970) ($cm/10^3y$)
Coastal batholith	7.8	1-5
Central batholith	45.9	
Andean batholith	42.7	2-10-80

CONCLUSIONS

Degree of fluid-rock equilibrium is higher for some areas in northern Chile than in the central-south region. In northern Chile, besides the extrusive type of magmatic activity, it is possible to distinguish a developed intrusive type -like in El Tatio- leading to the genesis of larger geothermal