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Hydrol. Earth Syst. Sci., 4, 332-340, 2000
www.hydrol-earth-syst-sci.net/4/332/2000/

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Geological factors affecting the chemical characteristics of the thermal waters of the carbonate karstified aquifers of Northern Vietnam

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Abstract. In northern Vietnam, exposed carbonate rock formations cover an area of more than 50,000 km². Their accumulated thickness from the Cambrian to the Triassic is in some places as much as 3000 m. Numerous thermal waters (springs and wells) occur in these strongly karstified carbonate massifs. This is the result of significant ancient and present orogenic activity, as the region demonstrates by its strong seismic activity. These karstic formations are water-bearing and strongly recharged by rainfall of between 1600 mm and 2000 mm per year in 90% of the area concerned. In view of the average annual air temperatures (17°C–25°C according to the region), 23 sample springs or wells were chosen with water temperatures of between 29°C and 68°C. Hydrochemical characteristics of these thermal waters emerging in different carbonate-rock units were examined by chemical analyses of major ions. In this large region, thermal waters are divided into four hydrochemical types: the Na-Cl type resulting from the intrusion of sea water for distances of up to several kilometres inland and depths of 1000 m, the Ca-SO₄ type, probably resulting from the leaching of deposits of metallic sulphides that are widely distributed in these carbonate-rock units, and finally the Ca-HCO₃ and Mg-HCO₃ types which are chemically similar to fresh karstic waters in limestones and dolostones. The occurrence of these thermal groundwaters as well as their chemical characteristics seem to indicate the existence of large-scale deepseated groundwater flow systems in the karstic aquifers.

Keywords: Vietnam; thermal waters; karst; hydrochemistry

[Final Revised Paper](#) (PDF, 1195 KB)

Citation: Drogue, C., Cat, N. N., and Dazy, J.: Geological factors affecting the chemical characteristics of the thermal waters of the carbonate karstified aquifers of Northern Vietnam, Hydrol. Earth Syst. Sci., 4, 332-340, 2000. [Bibtex](#) [EndNote](#) [Reference Manager](#)



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