Seismotectonic North-South Trending Llineaments of the Bohemian Massif: A New Paradigm

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Introduction

Recent integration of Landsat imagery interpretations together with geological, geophysical and geochemical data has allowed to define a complex north-south-striking seismotectonic zone that penetrates sedimentary and crystalline units of the Bohemian Massif (Fig. 1). The zone consists of a series of linear structures (photolineaments), at least some of which clearly correspond to deep tectonic faults. Present-day microearthquakes, discharges of thermal and mineral waters, small-scale occurrences of gases (N_2, He, CO_2, CH_4, Rn) and liquid hydrocarbons, and folded and fractured Late Tertiary to Quaternary sediments are all concentrated along these prominent structural trends and provide evidence of its persisting tectonic and fluid activity. Our research indicates that this system of major faults and fractures has probably played an important role in transporting and focussing fluids throughout geological history. The available data show that the movements of fluids along faults have occurred episodically and may have been tied to the earthquake cycles. Furthermore, we propose that north-south-striking seismotectonic zones, similar to those described in this work, are probably fairly common elsewhere in the Bohemian Massif.

Hydrothermal phenomena along the fault zones

Carbonate rocks that are penetrated by north-south faults show a variety of unusual corrosive features that are believed to be due to the influence of warm fluids. These phenomena which can be broadly described as *hydrothermal karst*, have been recently recognised in Lower Palaeozoic limestones of the Bohemian karst (central Bohemia) as well as in highly metamorphosed carbonate rocks of the Moldanubian unit of southern Bohemia. The morphology of many caves and caverns in the area indicates activity by uprising corrosive fluids with only minor later modifications by vadose erosion. Cupola-shaped cavities up to 1-2 m in diameter and circular ceiling dissolution pockets are commonly present. Most of the caves lack any internal mineralisation, having the wall rocks intensely corroded. Some caves, however, do contain exotic precipitates that include coarsely crystalline calcite spar coatings, manganese encrustations, carbonate-siliceous pisolites, and large fan-like aggregates of yellow columnar calcite. Indirect petrographic evidence, like convex rhombic calcite crystals and possible calcite replacements after aragonite encountered in early pisolitic sinters of the Bohemian karst point to the crystallisation from warm water rich in H_2S. Typically, both Moldanubian and Bohemian karst caves bear little or no relation to the modern topography, with epikarst and solution sinkholes being rare. The puzzling hydrological pattern of the caves and karst springs is readily indicative of deep conduits with little apparent relationship to the present-day drainage network. Eventually, a strong case for a hydrothermal nature of the caves is provided by the fact that many, if not most, caves are closely linked to subvertical, generally N-S or NNE-SSW - oriented faults and/or calcite veins. N-S-striking calcite veins of the Bohemian karst were recently shown to have precipitated from saline brines, at 55 - 115°C. Moreover, subrecent precipitation of aragonite, emissions of CO_2 and Rn in some caves, as well as thick subaerial deposits of calcareous sinters may indicate that fault-controlled endogenous karst-forming processes are still in action. To the north of Prague, ancient hydrothermal phenomena linked to seismotectonic zone are less obvious. We speculate, however, that at least some of present-day discharges of thermal and/or mineral waters may, in fact, represent fluid circulations controlled by N-S - trending lineaments. In this respect, large volumes of puzzling saline brines buried in Carboniferous sediments around the town of Slaný are also noteworthy.

Implications for the tectonic development of the Bohemian Massif

The role of north-south - trending linear tectonics in the Bohemian Massif has recently become increasingly clear. The synthesis of earlier works and our new observations now in progress indicates that equidistant N-S-trending fault system penetrates, in fact, the whole Bohemian Massif. A line of evidence also shows that these faults have been repeatedly reactivated during the geological history. Moreover, the geomorphologic analysis has revealed that N-S- and NNE-striking faults have played a vital role in forming a drainage pattern of the area; the seismoactive zone discussed in this paper corresponds to the main hydrographic axis of the Bohemian Massif which has operated over the area since the Pliocene.

Our study newly indicates that N-S linear tectonics of the Bohemian Massif has been instrumental in transporting warm fluids and gases from the basement toward the near-surface. It also shows that an intimate link exists between fault tectonics, microearthquakes, and pulsed episodes of fluid flow of warm brines and hydrocarbons, driven by seismic strain-cycling. This relationship can be of a fundamental importance for oil, gas, and ore prospecting in the Bohemian Massif and elsewhere.

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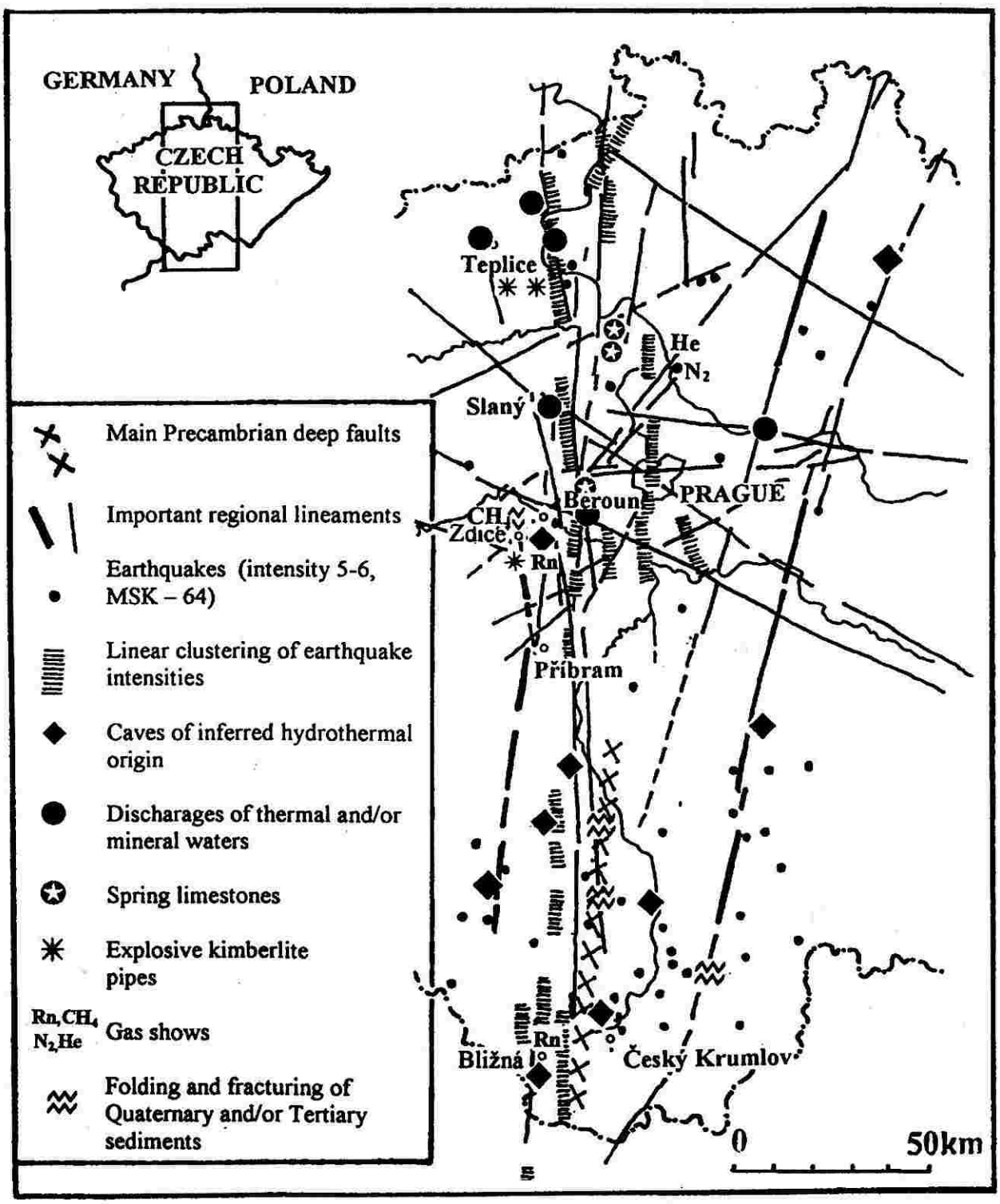

Fig. 1. Schematic presentation of prominent lineaments of the central part of the Bohemian Massif (modified after Lysenko 1986). Various geological phenomena spatially linked to the lineaments are also shown (see text for more details).