HELMHOLTZ CENTRE FOR ENVIRONMENTAL RESEARCH – UFZ

GFZ Helmholtz - Centre POTSDAM

Isotope geochemical characterisation of the natural CO_2 release in the border region Vogtland/NW Bohemia, Central Europe

Karin Bräuer[1], Horst Kämpf[2], Jens Schumann[2] and Gerhard Strauch[1]

1-Helmholtz Centre for Environmental Research - UFZ, 2-Helmholtz Centre Potsdam GFZ German Centre for Geosciences

Introduction

The Vogtland and NW Bohemia are part of the European Cenozoic rift system and are characterised by Quaternary volcanism, CO_2-rich mineral springs and mofettes, and the occurrence of swarm earthquakes. Several research projects on those mantle-related fluids have been successfully carried out using predominant isotope geochemical tools. Although in each case the projects were aimed at a specific topic, the results of all the projects together contributed to shedding light upon the origin of the fluids, the possible location of the fluid sources, the fluid migration paths, the role of fluids as a triggering mechanism for earthquake swarms in the Vogtland and NW Bohemia - the geodynamic situation as a whole.

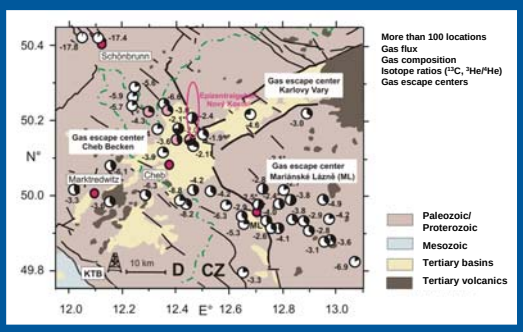

Fig. 1 Mapping of the degassing locations in the Vogtland/ NW Bohemia by helium and carbon isotopes. As a results three gas escape centers could be distinguished. The gas escape centers are characterized by high gas flux, CO_2 concentration of more than 99 vol. %, $\delta^{13}C$ values between -2 and -4‰ as well $^3He/^4He$ ratios between 2.4 and ≈ 6.0 Ra (black quarters correspond to the portion of mantle-helium related to MORB, the small numbers are the $\delta^{13}C$ values).

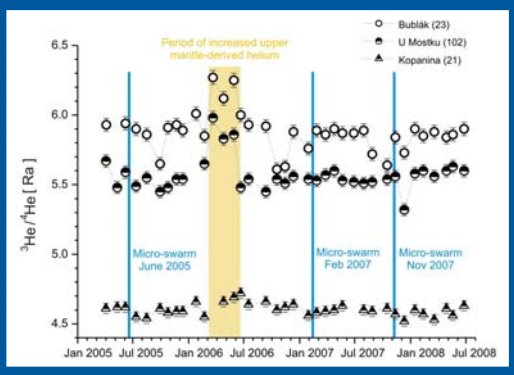

Fig. 3 Time-series (monthly sampling) of $^3He/^4He$ ratios between April 2005 and June 2008. Due to occurred micro-swarm seismicity crustal derived helium is released and result in repeatedly decrease of the $^3He/^4He$ ratios. The three month-lasting increase in spring 2006 is probably based on the supply of fresh undegassed magmatic volatiles from the deeper reservoir (Fig. 6)

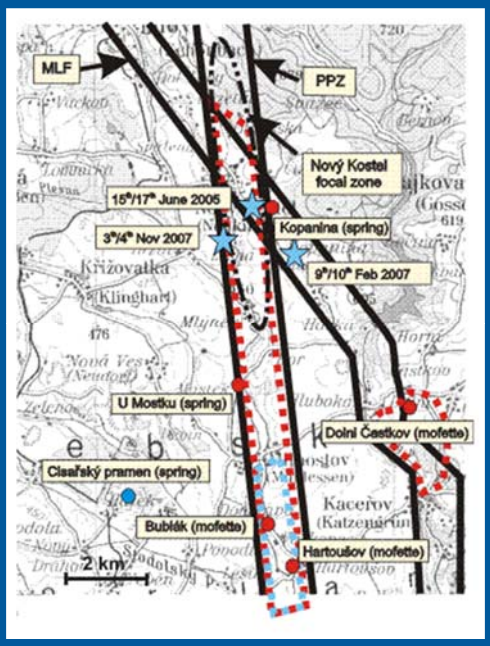

Fig. 2 Monitored sampling locations (Fig. 3) in relation to major faults (MLF = Mariánké Lázně fault zone; PPZ = Počatky Plesná fault zone) and to the Nový Kostel focal zone. The blue stars mark the June 2005, February and November 2007 micro-swarms. Dotted red are the CO_2 mapped areas. The blue dotted area marks a mofette field that has been characterised by measurements of CO_2-soil gas, gas flux, $\delta^{13}C$ and $^3He/^4He$ ratios (see Fig. 4).

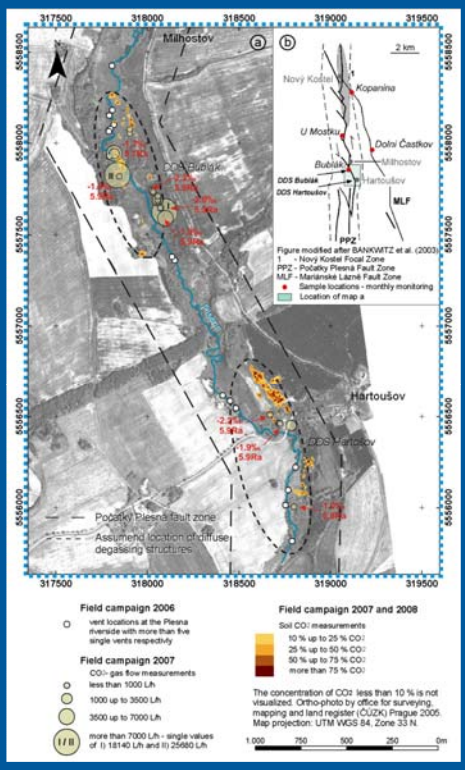

Fig. 4 Compiled results of CO_2 soil gas mapping and gas flux measurements (a: field indications; b: tectonic scheme). The red numbers correspond to the isotope ratios ($\delta^{13}C$, $^3He/^4He$ ratios) of gas-rich single vents.

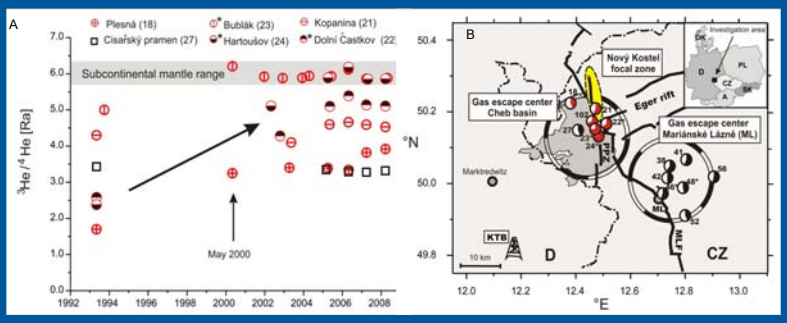

Fig. 5 The comparison of the data from the yearly sampling at several gas-rich locations of the gas escape center Cheb basin and Mariánské Lázne (B) result in a progressive increase of the $^3He/^4He$ ratios at locations in the eastern part of the Cheb basin (A). The increase of the $^3He/^4He$ ratios at these locations point to an ongoing magmatic process beneath this area (subcontinental mantle range from Dunai & Porcelli (2002)).

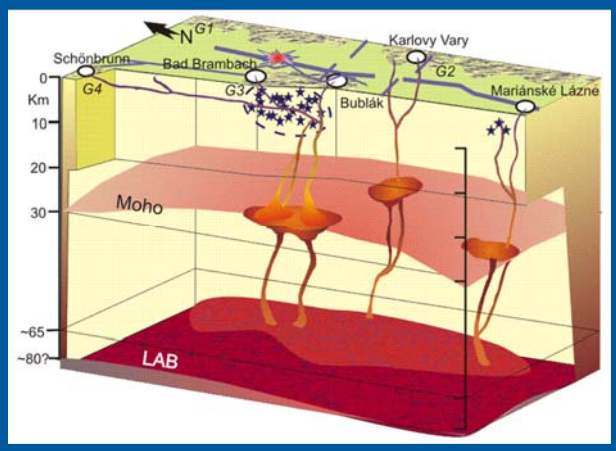

Fig. 6 Cartoon summarizing the present state of art of the geodynamic situation in the Vogtland/ NW Bohemia region from the view of fluid studies. There seems to exist several magmatic reservoirs at the crust/mantle boundary which are supplied by the same deep reservoir with mantle-derived fluids (G = granites, red star = epicentral area Nový Kostel, blue stars point to the focal zone in the upper crust between 6 and 12 km).

References

Bräuer, K., H. Kämpf, S. Niedermann, and G. Strauch (2005), Evidence for ascending upper mantle-derived melt beneath the Cheb basin, central Europe, *Geophys. Res. Lett.* 32, L08303, doi:10.1029/2004GL022205.

Bräuer, K.. H. Kämpf, U. Koch, S. Niedermann, and G. Strauch (2007) Seismically-induced changes of the fluid signature detected by a multi-isotope approach (He, CO_2, CH_4, N_2) at the "Wettinquelle", Bad Brambach (Central Europe), *J. Geophys. Res.* 112, B04307, doi:10.1029/2006JB004404.

Bräuer, K.. H. Kämpf, U. Koch, S. Niedermann, G. Strauch, and J. Tesař (2008), The natural laboratory NW Bohemia – comprehensive fluid studies between 1992 and 2005 used to trace geodynamic processes, *Geochem. Geophys. Geosys*. 9, Q044018, doi:10.1029/2007GC001921.

Bräuer, K., H. Kämpf, and G. Strauch (2009) Earthquake swarms in non-volcanic regions: What fluids have to say, *Geophys. Res. Lett*. 36, L17309, doi: 10.1029/2009GL039615

Dunai, T.J., and D. Porcelli (2002), Storage and Transport of Noble Gases in the Subcontinental Lithosphere, *Rev. Mineral. Geochem.* 47, 371- 409.

Weinlich, F.H., K. Bräuer, H. Kämpf, G. Strauch J. Tesař, and S.M. Weise (1999) An active subcontinental mantle volatile system in the western Eger rift, Central Europe: Gas flux, isotopic (He, C, and N) and compositional fingerprints, *Geochim. Cosmochim. Acta* 63, 3653-3671.

Conclusions

The portion of mantle-derived helium is higher along the PPZ than along the MLF. The subcontinental helium isotope signature of the gas ascending along the PPZ indicates highly permeable fluid transport pathways down to the lithospheric mantle.

The increasing seismic activity since 2002 has culminated in the October 2008 swarm the strongest period of seismicity since 1985/86 and may be driven by a long-lasting hidden magmatic activity beneath the Cheb basin.

The new time-series results of the gas and isotope composition appear to confirm ongoing magmatic and/or magmatically-driven activities beneath the Cheb Basin (Fig. 6), and indicate the usefulness of isotopic time series studies for tracing the spatial and temporal development of ongoing hidden magmatic processes.

At present the western Eger rift is the most active part of the European Cenozoic Rift system.