A Introduction and scope of this study

In this chapter, the general geological and geophysical settings of the area under study are introduced, including results from previous studies on the swarm-earthquake activity, volcano-tectonic evolution, and gasgeochemical and -isotope studies on CO_2-rich emanations. Furthermore, results from previous seismic and xenoliths studies in the region are presented.

A.1 The European Cainozoic Rift System and associated intraplate volcanic fields

The study area – the western part of the Eger Rift (Figure A.1) – belongs to the European Cainozoic Rift System (ECRS) [*Ziegler,* 1992; *Prodehl et al.,* 1995]. This system of graben structures and intraplate volcanic fields spreads over a distance of some 1000 km, including the French Massif Central, the Upper Rhine Graben, the Eifel, the North Hessian Depression, the Vogelsberg, the Eger Rift, the Elbe Zone, and the Pannonian Basin. Graben structures evolved on top of uplifted basement blocks (Variscan massifs); Tertiary and Quaternary volcanism is mainly concentrated on the flanks of these graben structures along boundary faults or on the adjacent uplifted blocks. Dominantly (ultra-) alkaline, but also more evolved, magmas were erupted. A detailed overview about the Cainozoic volcanism can be found in *Wimmenauer* [1974] and *Wilson and Downes* [1992]. The most recent expressions of magmatic activities within the European Cainozoic Rift System are the CO_2 degassing fields. The isotope (He, C, and N) composition of CO_2-rich gas emanations of mineral springs and mofettes from the French Massif Central [*Matthews et al.,* 1987], the East and West Eifel volcanic fields/Germany [*Griesshaber et al.,* 1992; *May*, 2002] and the western Eger Rift/Czech-German border region [*O´Nions et al.,* 1989; *Weinlich et al.,* 1999, 2003] gives evidence for the ascent of gases from fluid reservoirs in the European subcontinental mantle.

There are different models to explain the widespread rifting and associated volcanism in the foreland of the Alpine orogene. Most of them are related to the effects of Alpine collision [*Illies,* 1975; *Lippoldt,* 1982; *Ziegler,* 1992; *Stackebrandt and Franzke,* 1989; *Regenauer-Lieb,* 1999]. However, there also exist ideas of a mantle plume or several small mantle plumes (mantle fingers) as the source of the magmatic activity [*Granet et al.,* 1995; *Goes et al.,* 1999]. Such models mainly base on tomographic evidence. Teleseismic tomography studies have imaged anomalous low seismic velocities under the French Massif Central [*Granet et al.,* 1995] and the Eifel area/Rhenish Massif, Germany [*Ritter et al.,* 2001]. A combination of both end-member models was proposed by *Merle and Michon* [2001], who suggested mantle convection on a regional scale and therefore up-welling beneath the volcanic fields due to a descending lithospheric bulge beneath the Alps. The most recent overview on the evolution of the European Cainozoic Rift System is given by *Dezes et al.* [2004].

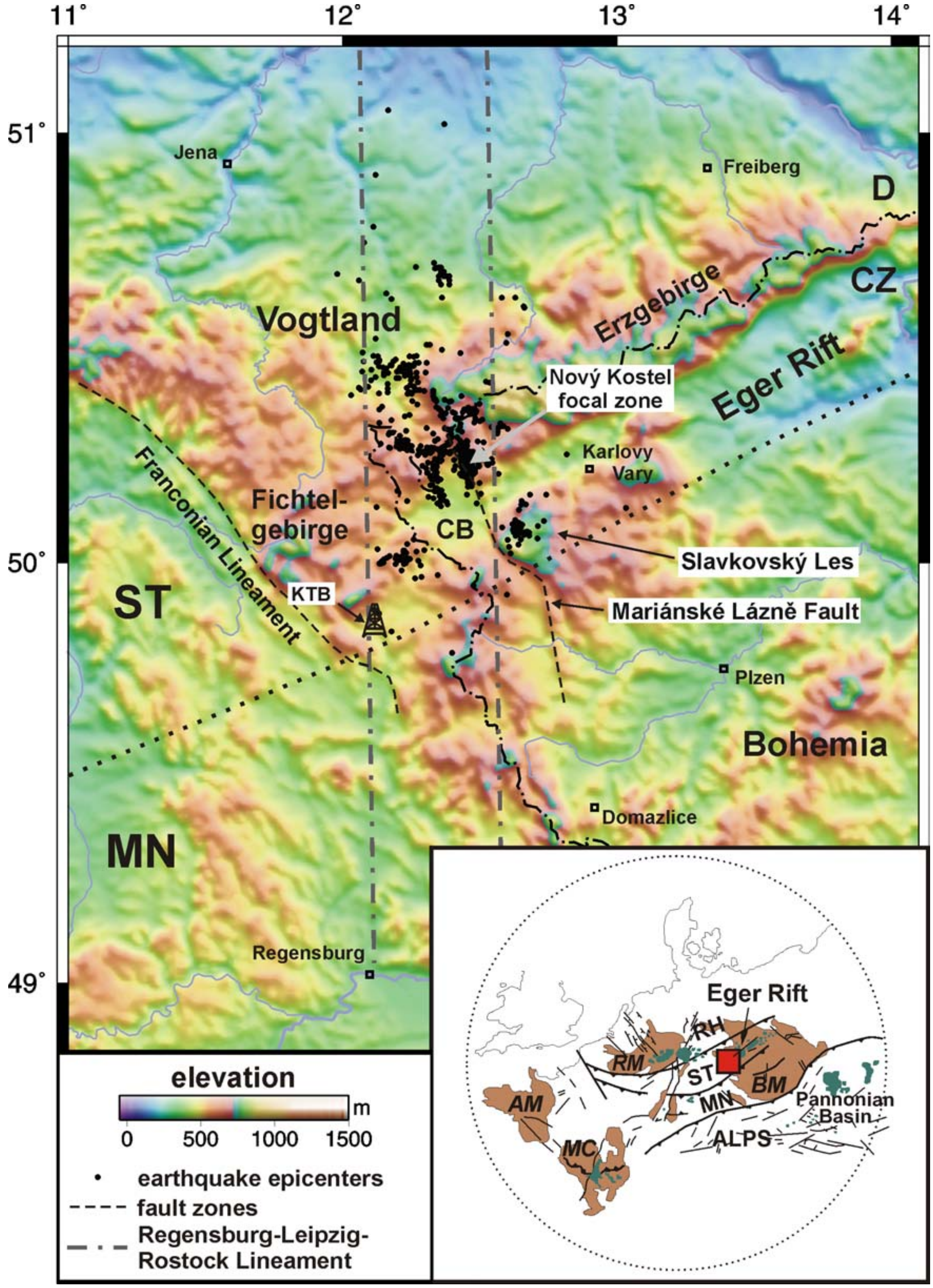

Figure A.1
Topographic map (GTOPO30 from USGS EROS DATA Center) of the northwestern part of the Bohemian Massif with earthquake epicentres 1985-1997 (black dots, according to *Neunhöfer* [2000] and SZGRF Vogtland Bulletin). Main earthquake swarm activity is concentrated in the Nový Kostel focal zone. Inset map: Position of the study area within the western and central European volcanic provinces modified after *Wilson and Downes* [1991] (read square – study area, green – Cainozoic volcanics, brown – basement massifs).
KTB – location of the German Continental Deep Drilling Boreholes (KTB), CB – Cheb Basin, MC – Massif Central, AM – Armorican Massif, RM – Rhenish Massif, BM – Bohemian Massif, MN – Moldanubian zone, RH – Rhenohercynian zone, ST – Saxothuringian zone.

A.2 Geological and geophysical settings of the western Bohemian Massif

The study area – the Vogtland/NW-Bohemia/NE-Bavaria region belongs to the western part of the Bohemian Massif and is situated in the transition zone between two Variscan structural units, the Saxothuringian zone (ST) in the north and the Teplá-Barrandian/Moldanubian zone (MN) in the south (see Figures A.1, A.2). These structural units are composed of magmatic and metamorphic rocks, which are covered by undeformed sediments of Permo-Carboniferous, Jurassic, Cretaceous and Cainozoic age in part. The whole region in the western and northern parts of the Bohemian Massif has been affected by alkaline magmatism/volcanism at least since the Upper Cretaceous.

A.2.1 Pre-Tertiary geology of the study area

The crust and uppermost mantle of the Bohemian Massif were profoundly affected by several geotectonic cycles (rifting, subduction, collision) during the last 2 Ga. Early stages of the evolution of continental crust and mantle in Central Europe from 2.0 Ga to 0.7 Ga are still unconfirmed. Nd crustal residence ages combined with xenocrystal and detrital zircon ages of crustal rocks from the NE margin of the Bohemian Massif suggest mixing of predominantly Paleoproterozoic material with subordinate amounts of juvenile material of Grenvillian age and Neoproterozoic to early Palaeozoic material [*Hegner and Kröner,* 2000]. The Avalonian-Cadominan/Panafrican evolution of terranes accreted in the Variscan belt of Central Europe shows several subduction events and island arc settings (660-540 Ma), obduction, intensive magmatism and crustal extension (540-530 Ma), and rifting/ocean basin formation (490-440 Ma) [*Linnemann et al.,* 2000]. During the Variscan orogeny the crust/lithosphere was affected by subduction, collision, thickening and post-collisional extension (360-280 Ma). Until now no structural evidence for these tectonic processes in Variscan and pre-Variscan times could be observed definitely within the upper mantle beneath Central Europe. There are only indications for divergent dipping paleosubduction zones from seismic anisotropy studies in the western Bohemian Massif [*Babuška and Plomerová*, 2001]. The influence and imprint of Mesozoic (especially Cretaceous) tectono-magmatic events on the present lithospheric structure is still poorly known. Such events are ultramafic magmatism in central Germany (UML-carbonatite complex of Delitzsch) [*Röllig et al.,* 1990; *Seifert et al.,* 2000] and Upper Lusatia [*Renno et al.,* 2003] and crustal stacking along the Franconian Lineament, as it is evident from the KTB area [e.g., *Zulauf and Duyster,* 1997a, b; *Wagner et al.,* 1997; *Tanner et al.,* 1998].

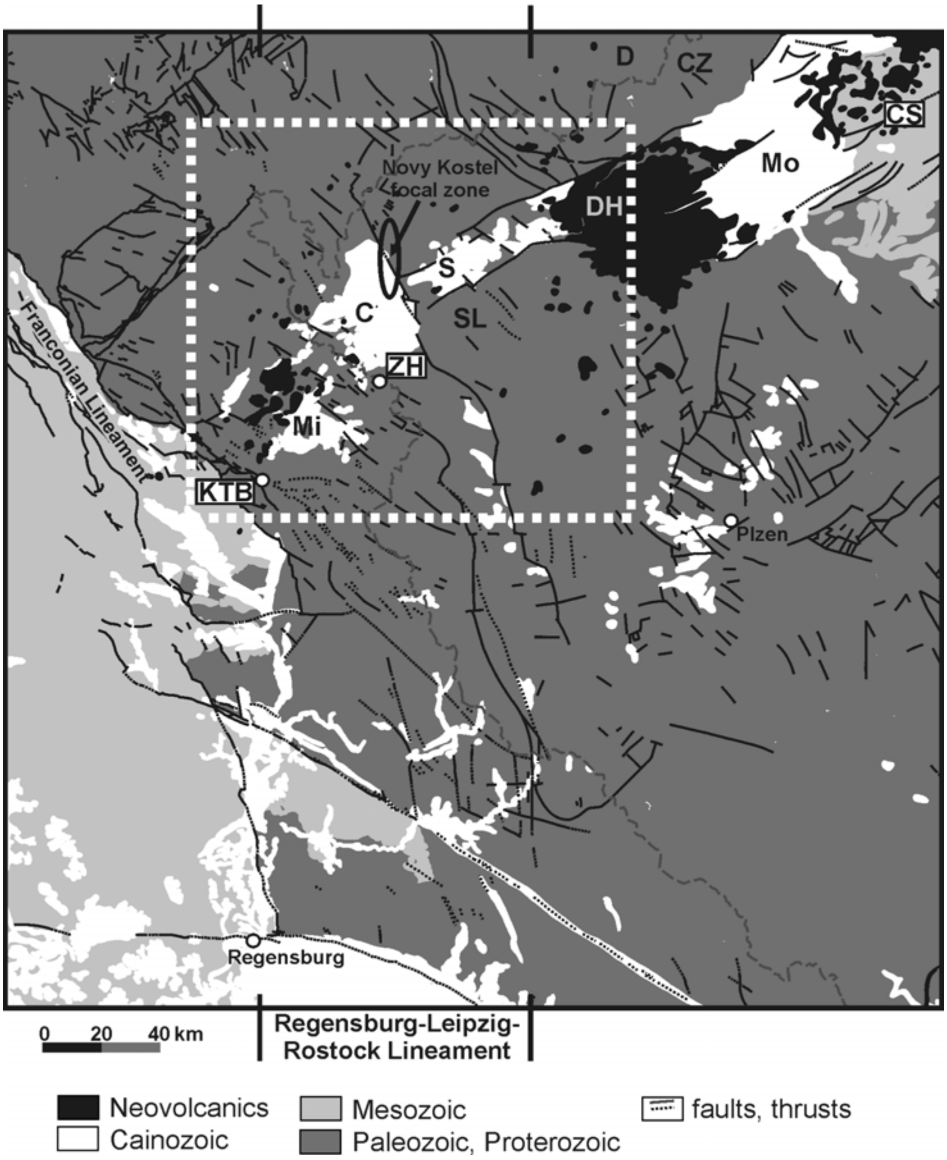

Figure A.2
Distribution of Tertiary-Quaternary volcanic fields and sedimentary basins in the western part of the Bohemian Massif [modified after *Bayerisches Geologisches Landesamt,* 1998]. The WSW-ENE striking line of the sedimentary basins: Mitterteich (Mi), Cheb (C), Sokolov (S), and Most (Mo) basins as well as the volcanic fields Doupovske Hory (DH) and Česke Středohoři (CS) belong to the Eger (Ohře) Rift. KTB = location of the German Continental Deep Drilling Boreholes; ZH – Železná Hůrka volcano, Quaternary (sample location for mantle xenoliths), SL – Slavkovský Les. The main working area (the western Eger Rift) is marked by the box.

A.2.2 Tectono-magmatic evolution of the Eger (Ohře) Rift

As already mentioned above, the Atlantic opening and Alpine orogeny affected Central and Western Europe during Cretaceous to Cainozoic times. Rifting and alkaline volcanism in the foreland of the Alpine orogene in this period were associated with either passive or active mantle up-welling. At the Upper Cretaceous-Tertiary boundary, an approximately 50 km wide and 300 km long ENE-WSW striking continental rift evolved in the area of the Palaeozoic suture originating from the collision of Laurasia (Laurentia-Baltica) and Africa (Gondwana). The Cretaceous to Quaternary tectono-magmatic evolution of the Eger Rift area comprises several phases [*Malkovský,* 1976; *Ulrych and Pivec,* 1997; *Ulrych et al.,* 1999; *Kämpf et al.,* 1999a; *Špičáková et al.,* 2000; *Renno et al.,* 2003]. Presumably, the magmatic activity began with plume activated dome uplift during the Early Cretaceous. The pre-rift phase was accompanied by mafic to ultramafic dike intrusions from the early Cretaceous to the Palaeocene (126 - 51 Ma). However, it is still uncertain if the Cretaceous magmatic activity is really related to the Eger Graben evolution. The main rifting phase with incipient graben formation and voluminous intraplate alkaline volcanism lasted from about 42 Ma to 9 Ma. A detailed overview of the Cainozoic volcanic activity in the western part of the Bohemian Massif is given by *Ulrych et al.* [2003].

The recent active rifting process during Quaternary with the further formation of the Cheb Basin is accompanied by CO_2 emanations at the surface in NW-Bohemia, southern Vogtland and eastern Fichtelgebirge area, sparse alkaline volcanic activity, neotectonic uplift in the Slavkovský Les area and earthquake swarm activity in the Vogtland/NW-Bohemia region.

A.2.3 Seismicity of the region

The Vogtland/NW-Bohemia region is known as one of the most interesting European earthquake swarm regions with thousands of small and intermediate magnitude swarm-earthquakes ($M_L < 5$). The term "earthquake swarm" (“Erdbebenschwarm”) was first introduced in this region more than hundred years ago by *Knett* [1899] and *Credner* [1900] for sequences of earthquakes that cluster in time and space. Primarily, earthquake swarms are a peculiarity of volcanic regions and mid-ocean rifts. Swarms in intraplate regions without active volcanism are unusual. Vogtland/NW-Bohemia represents such a region with an anomalous high swarm activity. The youngest known volcanic activity in the area occurred about 0.3 - 0.5 Ma [*Wagner et al.,* 2002; *Geissler et al.*, 2004b].

Within the last one hundred years stronger swarms ($M_L > 3$ to 4) were recorded at the turn of 19th to the beginning of the 20th century in 1897, 1901, 1903 and 1908 and at the end of the 20th century in 1985/86 and 2000 [*Bormann,* 1989; *Klinge et al.,* 2003; *Fischer and Horálek,* 2003; *Neunhöfer and Meier*, 2004]. Swarms with macro-seismically perceptible shocks also occurred in 1929, 1936 and 1962. After the 1962 swarm, the first local seismic network was installed. Duration of the main swarm activity of one or a few months including several phases of enhanced swarm activity (lasting only a few days) seems to be typical for large swarms. Smaller swarms ($M_L < 3$) with durations of a few days occur more or less regularly every 2 to 4 years. All stronger swarms in the last hundred years occurred at intersections between local faults of the N-S trending Regensburg-Leipzig-Rostock Lineament with ENE-WSW, NW-SE and NNW-SSE trending faults [*Hemmann and Kämpf,* 2002]. Since 1985/86 most swarms are located near Nový Kostel (50.24°N, 12.44°E) following a 14 km long N-S trending line in a depth of about 8 km at the intersection of the N-S trending Nový Kostel-Počátky-Zwota zone with the NNW-SSE trending Mariánské Lázně fault zone (Figure A.3) [*Švancara et al.,* 2000; *Bankwitz et al.,* 2003a, b; *Fischer and Horálek,* 2003]. The earthquakes of individual swarms are clustered in extremely small volumes of only a few cubic kilometres [*Fischer and Horálek,* 2003; *Neunhöfer and Meier*, 2004]. The N-S trending Regensburg-Leipzig-Rostock Lineament seems to continue further to the south into the Molasse Basin and the Alps [*Lehrberger et al.,* 2003].

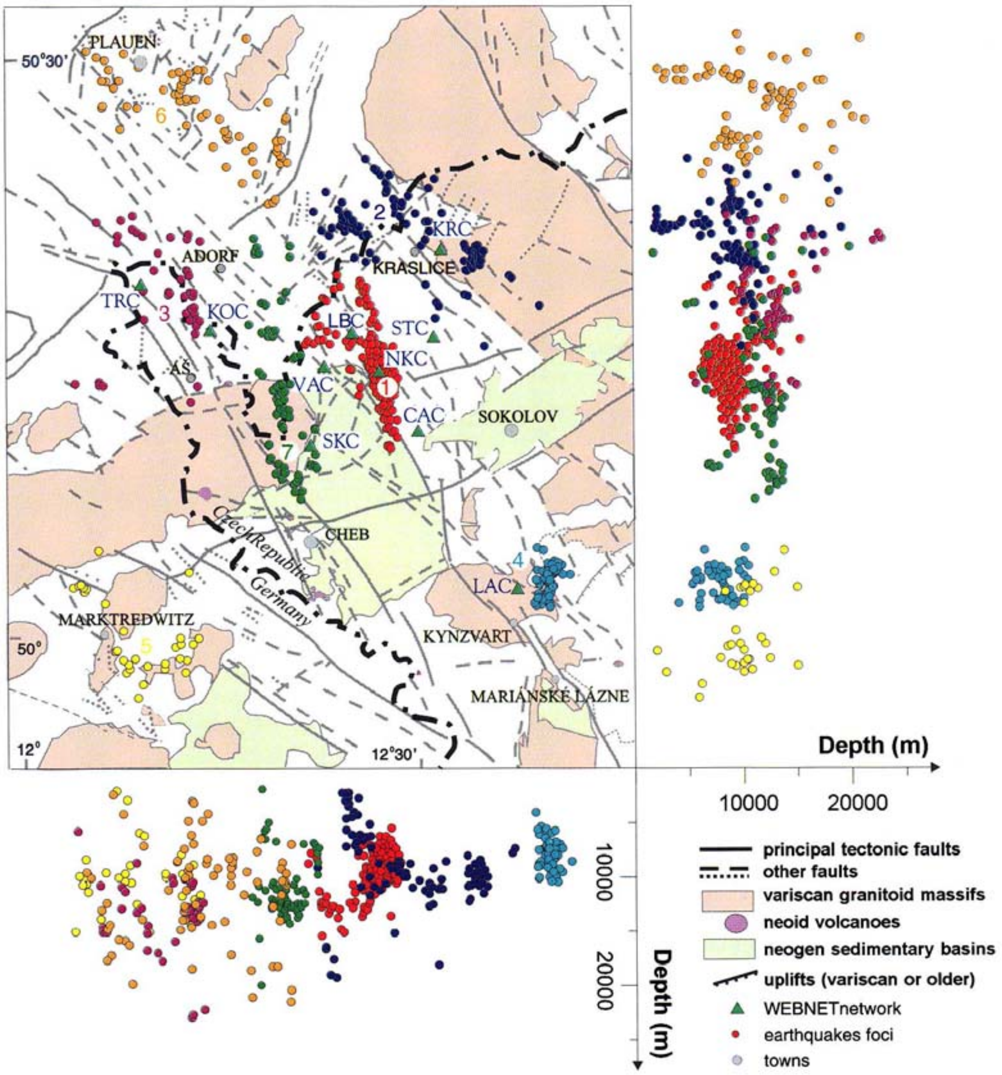

Figure A.3
Spatial distribution of earthquake hypocentres 1991-1999 [from *Horálek et al.,* 2000] based on locations with WEBNET and KRASLICE network stations. Seven focal zones were distinguished by colours. Recently, the main earthquake swarm activity is concentrated in the Nový Kostel focal zone (red).

Focal mechanisms of most of the events with $M_L > 2$ since 1985 show similar patterns of seismic dislocation [*Wirth et al.,* 2000]. Sources with significant non-double-couple components up to 60 % dominated in the second and third phases of the January 1997 swarm in the main focal zone Nový Kostel [*Horálek et al.,* 2000a, 2002]. Similarly, non-double-couple (20 to 40 %) sources were revealed for some events of the 2000 earthquake swarm (focal zone Nový Kostel) by *Plenefisch and Klinge*

[2003]. Source mechanisms with significant non-double-couple components indicate tensile earthquakes, which seem to be caused by a high-fluid pressure in the region [*Vavryčuk,* 2001]. *Parotidis et al.* [2003] hypothesized ascending magmatic fluids trigger the earthquakes by causing pore-pressure perturbations, which change the effective stresses resulting in seismic activity. Recent studies show, that also seismic anisotropy in the source region should be considered when discussing non-double-couple components [*Rössler et al.*, 2003].

The most recent earthquake swarm with about 70 events (M_{Lmax}=1.4) was registered on February 22, 2004 near Nový Kostel [*Boušková et al.,* 2004]. It did not occur in the main focal zone. The depth was estimated to about 14 km, i.e. deeper than the presumed 12 km of the brittle-ductile boundary in this area [*Boušková et al.,* 2004].

A.2.4 CO_2 emanations at the Earth's surface

In principle, insights from seismological and geochemical results point to a general connection between fluid flow (predominantly CO_2) and seismic activity in the crust of the studied area [*Kämpf et al.*, 1992; *Kämpf,* 1994; *Weise et al.*, 2001; *Vavryčuk,* 2001; *Bräuer et al.*, 2003; *Parotidis et al.,* 2003]. Recently, a subcontinental mantle related gas flow to the Earth's surface was observed indicating a correlation between the gas flow rate and the earthquake swarm activity for the year 2000 [*Koch and Heinicke,* 2003].

Previously, the composition and flux of gas emanations, and the isotopic ratios of CO_2 and He of 101 mineral springs and dry gas vents (mofettes) in the western Eger Rift were analysed [*Weinlich et al.*, 1999, 2003; *Geissler et al.,* 2004a] The CO_2-dominated portion in the free gas phase (> 99 vol.% CO_2) cluster in an area of approximately 1500 km^2 (Figure A.4). Four geochemically similar, but tectonically separate gas escape centres could be distinguished: Františkovy Lázně / Cheb Basin (I), Mariánské Lázně (II), Konstantinovy Lázně (III), and Karlovy Vary (IV). The gas escape centres I, II, and IV show always a free gas flux of more than 85000 dm^3 h^{-1} [*Weinlich et al.*, 1999]. All gases are CO_2-rich (> 99 vol.% CO_2) and have $\delta^{13}C$ values ranging from -1.8 to -4.0‰. The $^3He/^4He$ ratios reach up to 5.9±0.17 Ra in the Cheb Basin (mofette Bublák) as a mean value of 14 samples [*Bräuer et al.,* 2004]. Olivine phenocrysts and xenoliths from the subcontinental lithospheric mantle (SCLM) show a homogeneous helium isotopic ratio (R/Ra) of approximately 6.1 [*Gautheron and Moreira,* 2002]. The helium isotope ratios of the Cheb Basin [*Weinlich et al.*, 1999, 2003; *Bräuer et al.,* 2004] are in the same range as found for xenoliths from the sub-continental mantle worldwide [*Gautheron and Moreira,* 2002]. That makes it plausible, that the CO_2-dominated gas of the gas escape centres at the surface carries a very high portion of pure lithospheric mantle (SCLM) fluid. Helium, CO_2, and other volatiles may be released during melting/crystallization in the lithospheric continental mantle.

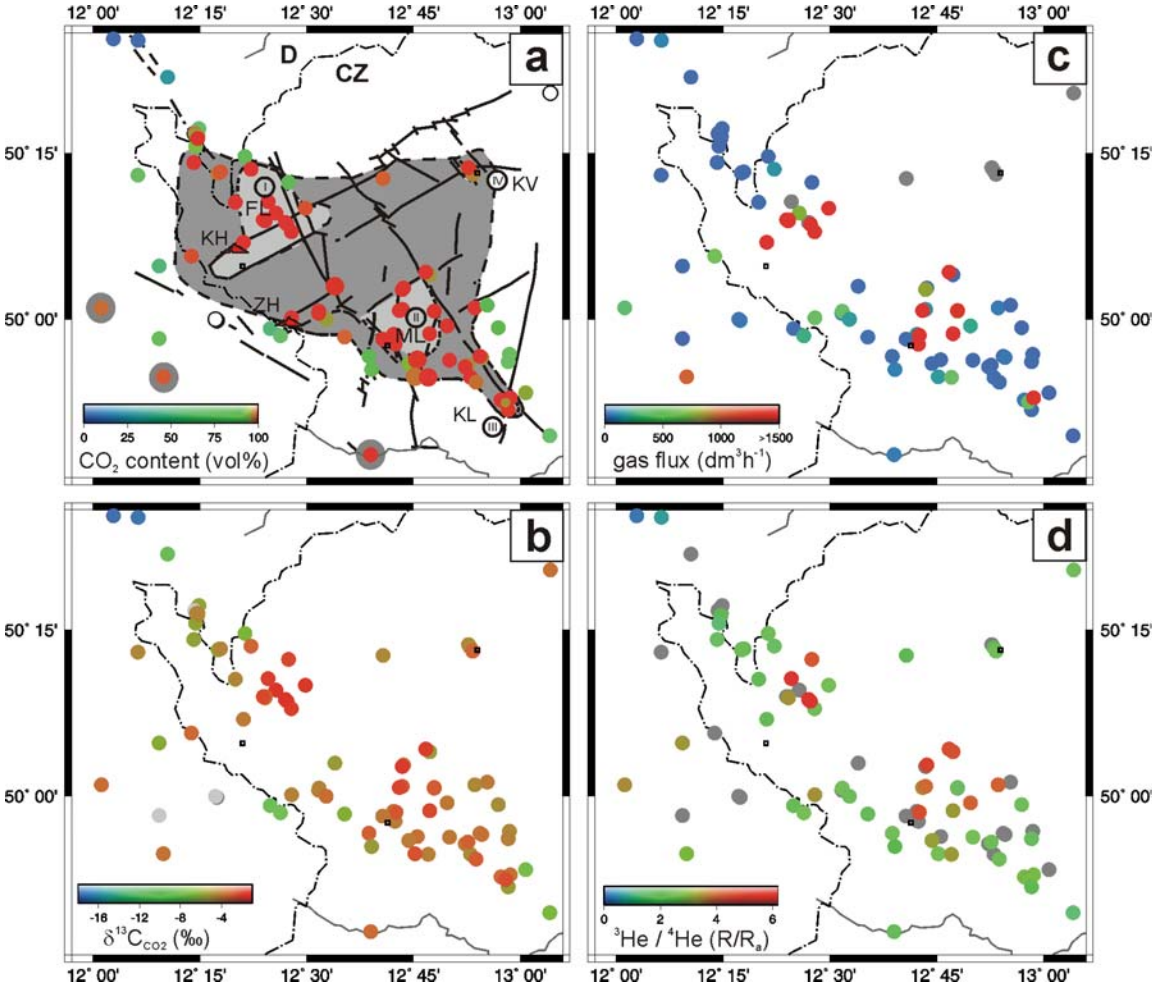

Figure A.4
Results from gasgeochemical and –isotope (C, He) studies of CO_2-dominated emanations in the Vogtland/NW-Bohemia area [data from *Weinlich et al.,* 1999, 2003; *Geissler et al.,* 2004a]. **(a)** CO_2 content of the free gas phase of mineral springs and mofettes: light grey – CO_2 escape centre; dark grey – surrounding of the main escape centres, the CO_2 content of the dark grey coloured area is >99 vol.% [after *Weinlich et al.,* 1999]; **(b)** $\delta^{13}C$ values: the $\delta^{13}C$ values of the CO_2 escape centre and surrounding of the degassing centres ranging from –1.8 to –4.0‰; **(c)** gas flux (free gas): flux within the main escape centres FL and ML is significantly higher than it could be indicated by the colour-scale; **(d)** $^3He/^4He$ (R/Ra) ratios: the helium isotopic ratios of the CO_2 escape centre and the periphery, ranging from R/Ra 5.9 to 0.2.
FL – Františkovy Lázně, ML – Mariánské Lázně, KL – Konstantinovy Lázně, KV – Karlovy Vary, KH – Komorní Hůrka, ZH – Železná Hůrka.

The two most prominent high gas flux CO_2 degassing centres (Františkovy Lázně / Cheb Basin and Mariánské Lázně) cluster in areas of approximately 150 km^2. The gas flux, CO_2 content, $\delta^{13}C$ values, and $^3He/^4He$ ratios decrease with distance from the CO_2 emission centres, whereas the fractions of N_2 and trace gases increase (Figure A.4b-d). *Bräuer et al.* [2003] estimated that the fluid transport velocity in the upper crust ranges between 400m/day near a centre of CO_2 emanation and 50m/day in the periphery. $^3He/^4He$ ratios, $\delta^{13}C$ values, gas composition, gas flux rate and fluid transport velocity give evidence for a deep-seated, presently active magmatic source.

The location of the degassing centres at the surface points to the location of the covered magmatic source. This magmatic degassing at the surface in the Vogtland/NW-Bohemia area was the main motivation to start this local-scale mapping of the Moho discontinuity and the subcrustal mantle.

A.3 The Moho and the upper mantle in previous studies

A.3.1 The Moho structure

In the past the region was studied by several reflection and refraction seismic experiments [e.g., *Giese,* 1976; *DEKORP Research Group,* 1988, 1994; *Bormann et al.,* 1989; *Schmoll et al.,* 1989; *Schulze and Lück*, 1992; *Behr et al.,* 1994; *Tomek et al.,* 1997; *Enderle et al.,* 1998]. Some of these measurements were related to the German Deep Drilling Project "Kontinentale Tiefbohrung" (KTB) [*Emmermann and Lauterjung,* 1997]. The mean P-wave velocity of the crust in the area under investigation ranges between 6.0 and 6.3 km/s with higher values towards the south within the Bohemian Massif [e.g., *Bormann et al.,* 1989].

The Moho discontinuity in the KTB area is not uniformly imaged by reflection seismic studies. It exists only locally as a pronounced reflector [*Tillmanns et al.,* 1996]. An updoming of the Moho discontinuity beneath the boundary region of the Moldanubian and Saxothuringian zones was reported, but the reflection character is diffuse [*DEKORP Research Group,* 1988].

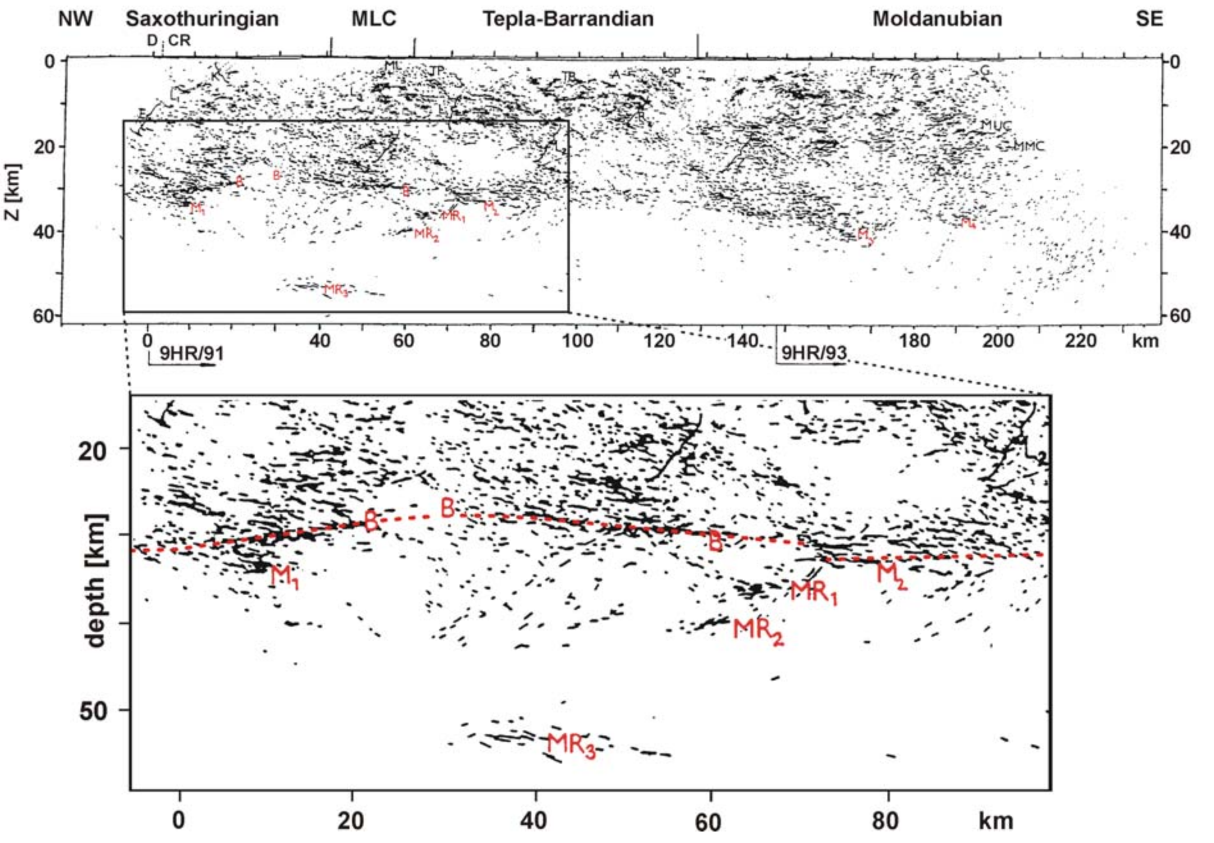

Figure A.5
Results from deep-seismic reflection profile 9HR, running from the Czech-German border near Klingenthal south-eastwards [*Tomek et al.,* 1997]. See Figure B.2 for location of the profile. The profile crosses the study area between the border and the Tepla-Barrandian Unit. M_{1-4} are interpreted as Moho reflections; B possibly stem from basaltic intrusions; MR_{1-3} denote upper mantle reflections. A Moho antiform beneath the Saxothuringian zone is clearly visible, exactly where the Eger Graben is located at the surface (Sokolov Basin).

The crustal thickness along the profile DSS-VI is about 30 km where it crosses the Eger Rift east of Karlovy Vary [*Mayerová et al.,* 1994]. A crustal thickness of 28 km in the western Erzgebirge region was published by *Bormann et al.* [1989]. The crust thickens southwards to about 37 km in the Central Moldanubian [*Mayerová et al.,* 1994]. No clear Moho reflections were recorded beneath the western Eger Rift by the reflection seismic profile 9HR, which runs from near station KLIN to BOH2 (see Figure B.2) and further to the southeast [*Tomek et al.,* 1997; Figure A.5]. The interpolation of the inclined Moho reflection bands in the north and south results in an approximate Moho depth of 29 km (9.2-9.5 seconds two-way travel-time (TWT), $v_p = 6.3$ km/s). The Moho depth north of the Eger Rift ranges from 30 to 32 km [*Enderle et al.,* 1998].

Based on the existing seismic data many regional contour maps of Moho depth were compiled [e.g.; *Bormann et al.,* 1989; *Mayerová et al.,* 1994; *Prodehl et al.,* 1992, 1995; *Giese,* 1995; *Dezes and Ziegler*, 2002; see Figure A.6]. The problem of almost all seismic profiles in the past is, that they end at the border between countries, and therefore, maps of Moho depth do not show the complete Moho topography of the area under investigation.

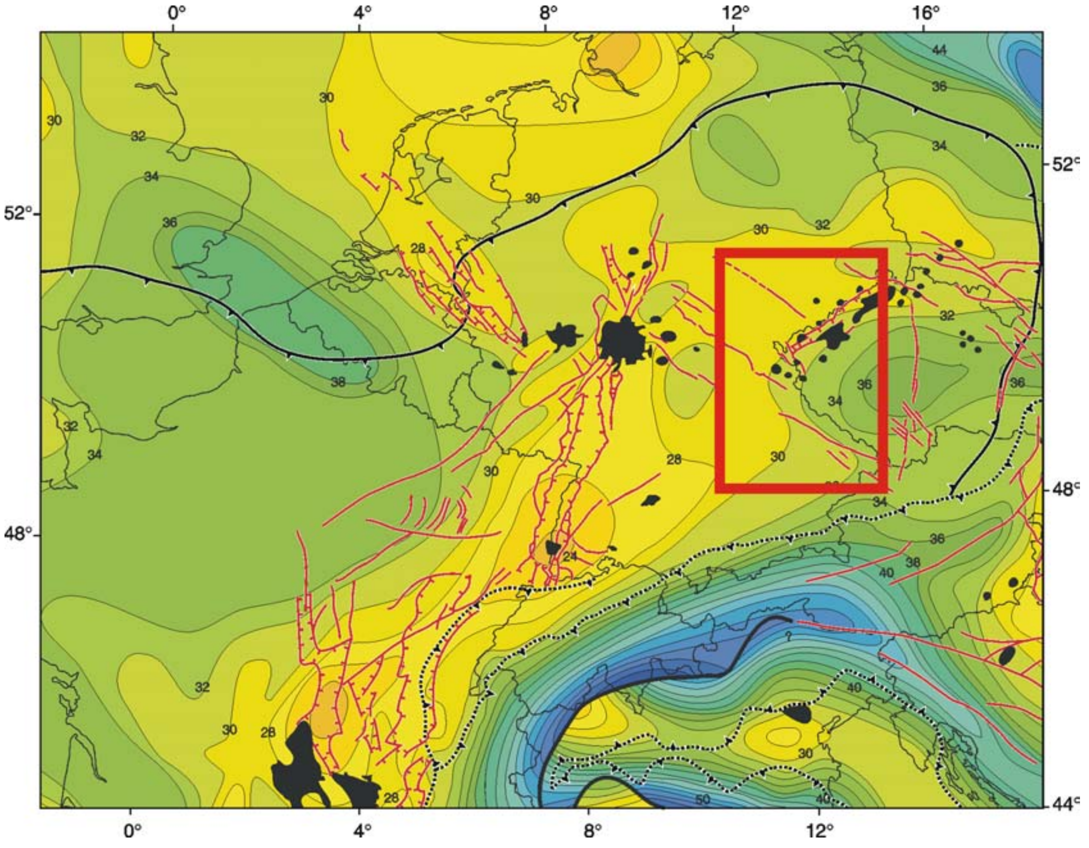

Figure A.6
Depth of the Moho discontinuity (km) in Central Europe from *Dezes et al.* [2004] with the position of the study area (red square). Also shown are the positions of Cainozoic volcanic centres (black filled areas), major graben structures and fault zones (red lines), as well as the position of the Variscan Deformation Front (solid black line) and Alpine thrusts (dotted black lines). The Moho depth beneath the study area ranges from about 28 to more than 36 km, according to *Dezes et al.* [2004].

A.3.2 Seismic constraints on the upper mantle structure

Global seismic tomography imaged a low velocity structure between 660 and 2000 kilometres depth beneath Central and Western Europe [*Goes et al.,* 1999]. Mantle fingers with low seismic velocities were found in the uppermost 300 km beneath the French Massif Central and the Eifel/Rhenish Massif by *Granet et al.* [1995] and *Ritter et al.* [2001], respectively. There are also indications for reduced seismic velocities in the upper mantle beneath the western Eger Rift region, mainly from studies of P wave residuals [*Rajkes and Bonjer*, 1976; *Faber et al.,* 1986; *Plomerová and Babuška,* 1988; *Plomerová et al.,* 1998]. *Passier and Snieder* [1996] obtained a three-dimensional shear wave velocity distribution beneath central and southern Germany. Prominent features of the model are low velocities in the uppermost mantle between 80 and 120 km along the Eger Rift, and between 80 and 200 km beneath the western Eger Rift and the Eifel. *Passier and Snieder* [1996] suggest the creation of magma in the asthenosphere or at the base of the lithosphere beneath these regions. However, a coupling between the lower and upper mantle beneath central and Western Europe has remained widely speculative. Coupling between the upper mantle fingers and the crust is also not well understood. Resolution differences between the different seismic methods used so far cause a structural gap in this subcrustal depth range.

A.3.3 Results of thermobarometric studies on xenoliths from adjacent volcanic fields

As already mentioned above, the probable source region of the (ultra-) mafic magmas (nephelinitic-melilititic) is the boundary between the asthenosphere and the basal lithosphere (the uppermost mantle). If the magmas erupt directly from those depths, they often contain inclusions (cognate and xenolithic), which give important information on the composition of the uppermost mantle and lower crust, as well as on geodynamic processes in the lithosphere (metasomatic-magmatic overprinting, deformation, partial melting). The Tertiary volcanic fields adjacent to the area under study were already investigated in terms of the origin of their spinel peridotite inclusions (Table A.I). First geothermobarometric results from NE-Bavaria (western prolongation of the Eger Rift) were published by *Huckenholz and Noussinanos* [1977] and later by *Huckenholz and Kunzmann* [1993]. Spinel peridotites and crustal xenoliths within the volcanic rocks of the Rhön were studied by *Franz et al.* [1997], *Franz and Seifert* [1998], and *Witt-Eickschen and Kramm* [1997]. Mantle and lower crustal xenoliths from the Elbe fault zone and Upper Lusatia (eastern Eger Rift area) were investigated, e.g., by *Kramer* [1988], *Seifert and Kramer* [2000], *Vokurka and Povondra* [1983], *Medaris et al.* [1997, 1999], and *Ulrych et al.* [2000]. Mean temperatures of equilibration of spinel lherzolites, harzburgites, and wehrlites range from 840°C to 1270°C; equilibration pressures between 10 and 27 kbar (30-90 km depth) were obtained by the different authors.

Table A.I Results of geothermobarometric studies on upper mantle xenoliths from volcanic fields adjacent to the western Eger Graben area (Rhön, NE Bavaria, Elbe Zone – eastern Eger Rift area).

Locality	**xenolith type**	**T [°C]**	**p [kbar]**	**reference**
NE-Bavaria	sp-lherzolites	1139±15	26±2	*Huckenholz and Noussinanos* [1977]
	groundmass	~1000		
	sp-lherzolites	920-1075		*Huckenholz and Kunzmann* [1993]
Rhön	sp-lherzolites/ wehrlites	840-1050	11-24	*Franz et al.* [1997]
	sp-lherzolites/ harzburgites	1190-1270	19-26	
	sp-lherzolites	920-950	10-13	*Witt-Eickschen and Kramm* [1997]
		840-850	26-27	
Kozákov	sp-lherzolites	1243±33	17.7±2.4	*Vokurka and Povondra* [1983]
	sp-lherzolites	975-1090	12.0-18.6	*Medaris et al.* [1997, 1999]
Elbe Zone	sp-lherzolites	1110		*Kramer and Seifert* [2000]
	harzburgites	1040		
Eastern Erzgebirge	sp-lherzolites	1020		*Kramer and Seifert* [2000]
	harzburgites	955		
Lusatia	sp-lherzolites	1000		*Kramer and Seifert* [2000]
	harzburgites	860		

The former presence of garnet within some spinel lherzolite samples was inferred from LREE/HREE ratios, occurring pyroxene-spinel clusters, and isotopic ratios (^{143}Nd/^{144}Nd) of clinopyroxenes [*Witt-Eickschen and Kramm,* 1997]. According to *Witt-Eickschen and Kramm* [1997], garnet-bearing peridotite entered the spinel stability field as a consequence of mantle diapirism. The age of metasomatism and enrichment of former depleted upper mantle is discussed as pre-Cainozoic, probably Hercynian in age. K-Ar model ages of xenoliths from Saxony, ranging between 89 and 254 Ma, are possible indications for an upper mantle where Variscan and older mantle melts were derived from [*Kramer*, 1988].

A.4 Scope of this study

The results of teleseismic tomography and fluid mapping at the surface (gas composition, gas flow, isotopes) in continental rift environments (e.g., European Cainozoic Rift System) are not completely compatible. Teleseismic tomography studies are commonly focused to >100 km depths, whereas the data of magma/gas researches are mainly directed to subcrustal and crustal depths (<100 km). The results of the fluid mapping from the western Eger Rift/Czech-German border region [*O´Nions et al.,* 1989; *Weinlich et al.,* 1999, 2003] have to be combined with geophysical and petrological indications for the lithospheric structure in the same area to locate the source region of the gases and to understand the deep covered processes, which lead to the observed fluid activity. This was the motivation to start a local-scale mapping of the Moho discontinuity and the subcrustal mantle in the Czech/German border area of the western Bohemian Massif using seismic and petrological methods.

This work consists of two main parts including results from two different geoscientific methods. At first, I present results from a passive seismic study (Ps receiver functions). At second, I present petrological data and their interpretation from a xenolith study. Finally, I try to integrate the results from both methods into a conceptional model that is able to explain the new seismic and petrological data together with results from previous seismic, seismological, and gasgeochemical investigations. The combination of xenolith investigations and geophysics is a useful tool to study the crust-mantle transition, as it is already mentioned by *O'Reilly and Griffin* [1985]: "The integration of petrological and geophysical data allows interpretation of stratigraphy of the lower crust – upper mantle, of the nature of the Moho and of the thermal evolution of the upper lithosphere for the time range represented by the host volcanic rocks".

I discuss the seismic structure and possible petrological composition of the crust-mantle boundary and the uppermost mantle beneath the western Eger (Ohře) Rift in relation to the composition, isotope (C, He) geochemistry and gas flow of active mantle fluids (CO_2-dominated emanations at the surface), magmatic underplating of the continental crust and intraplate seismicity (earthquake swarms in the upper crust). Direct compilation of seismic evidence (e.g., Moho depth map) with composition, gas flow and isotope (He, C) values of fluids are rare in the literature [*Marty et al.,* 1992].