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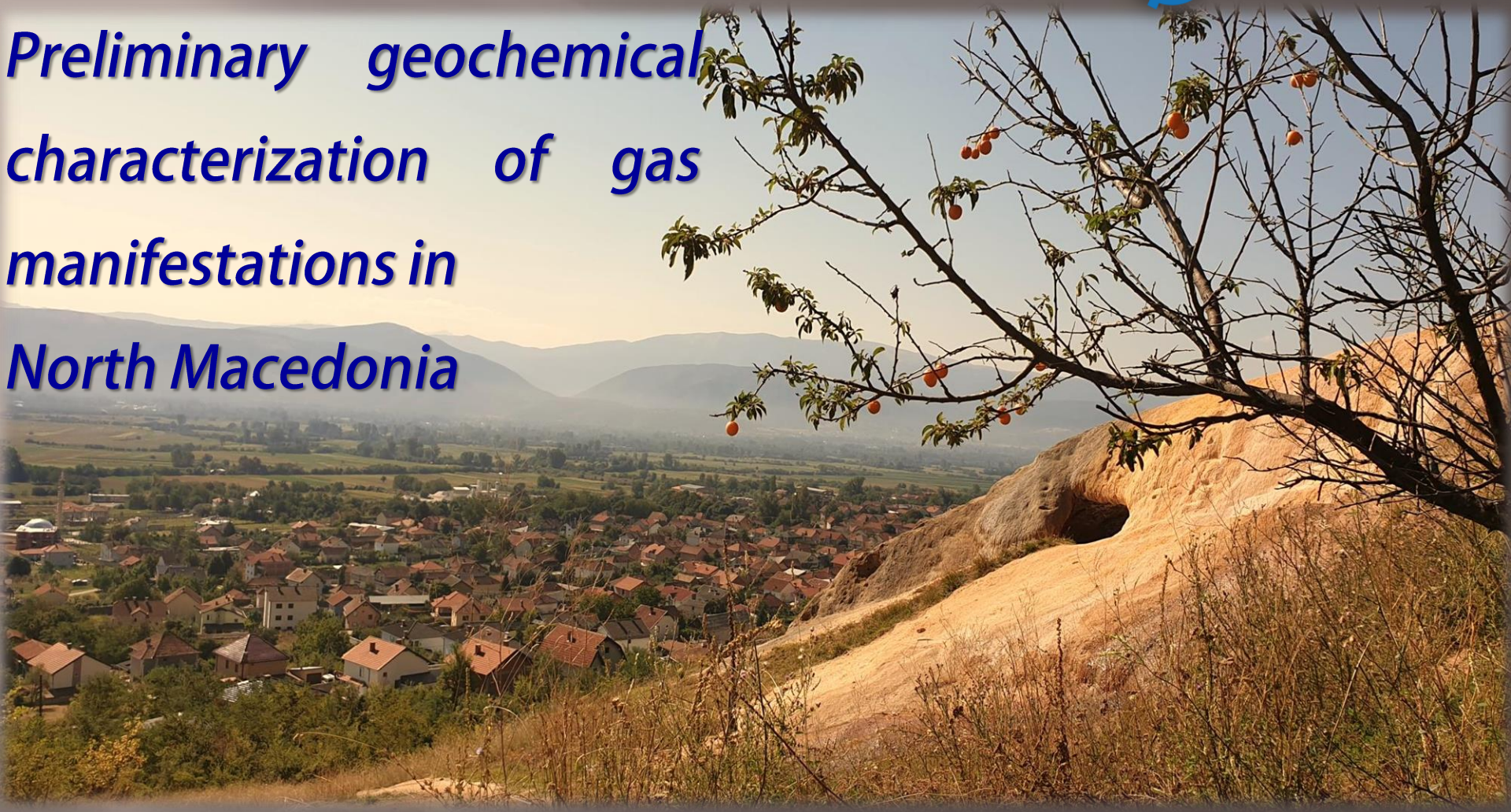
EGU General Assembly 2020

Preliminary geochemical characterization of gas manifestations in North Macedonia



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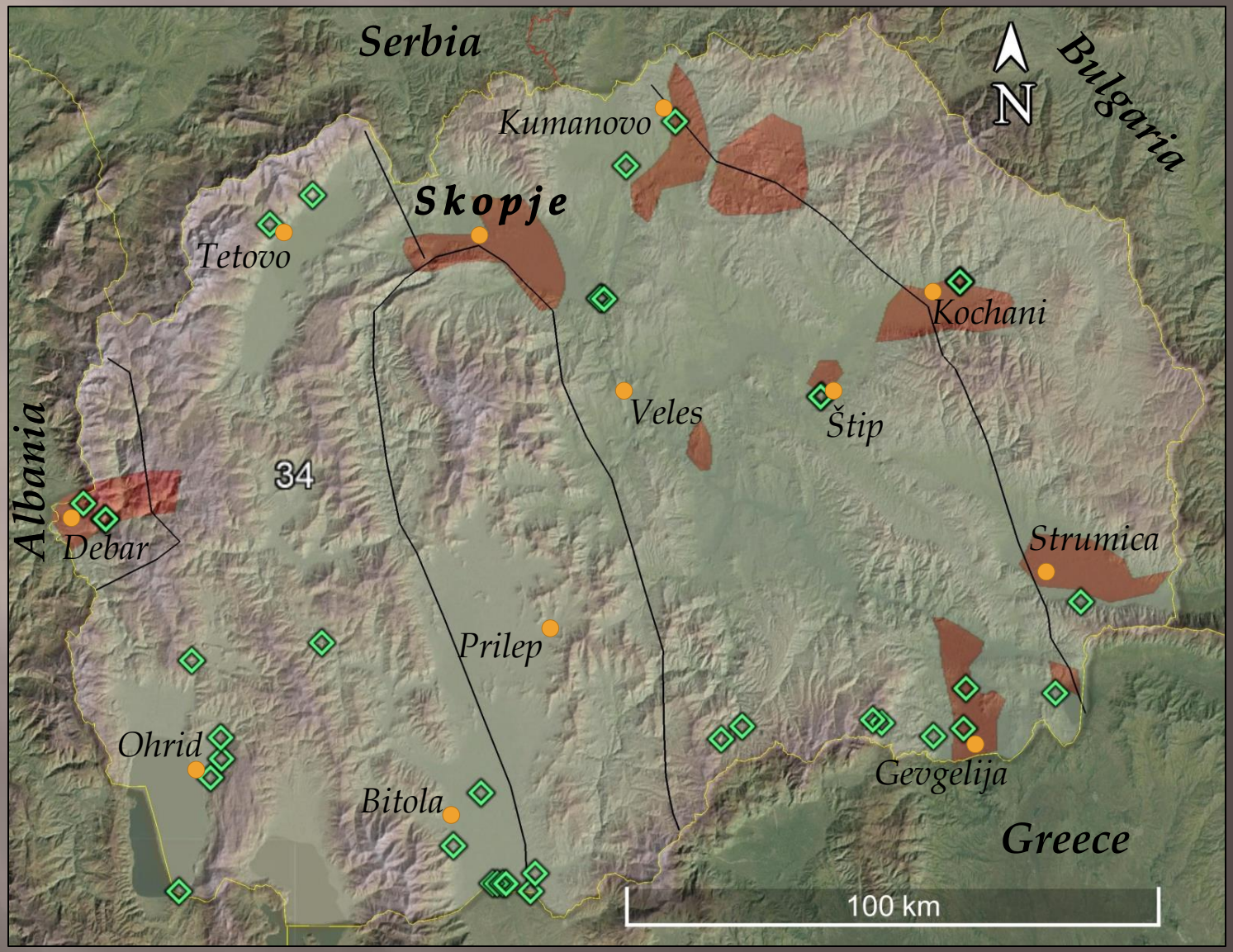
Isotope Climatology and Environmental Research Centre

ISTITUTO NAZIONALE DI GEOFISICA E VULCANOLOGIA

UNIVERSITÀ DEGLI STUDI DI PALERMO

UNIVERSITATEA BABEŞ-BOLYAI

Study area: Republic of North Macedonia



In 2019-2020 period, more than 50 gas samples from thermo-mineral waters and soil gases have been collected all around the country

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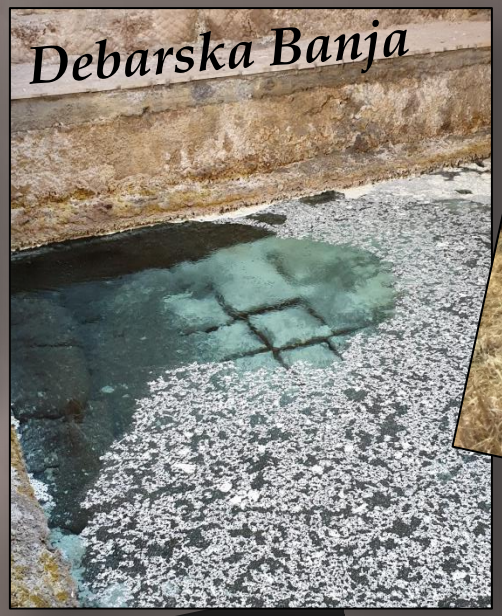
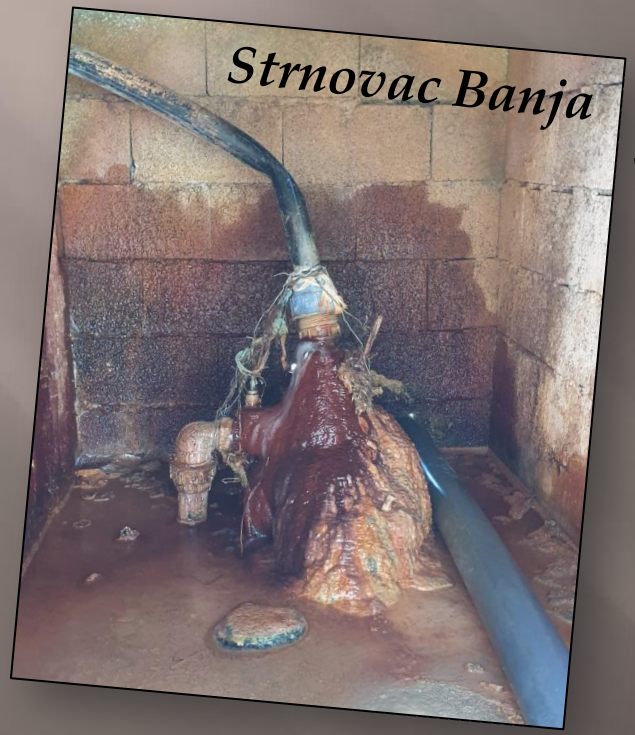
Study area: Republic of North Macedonia

Smrdliva Voda

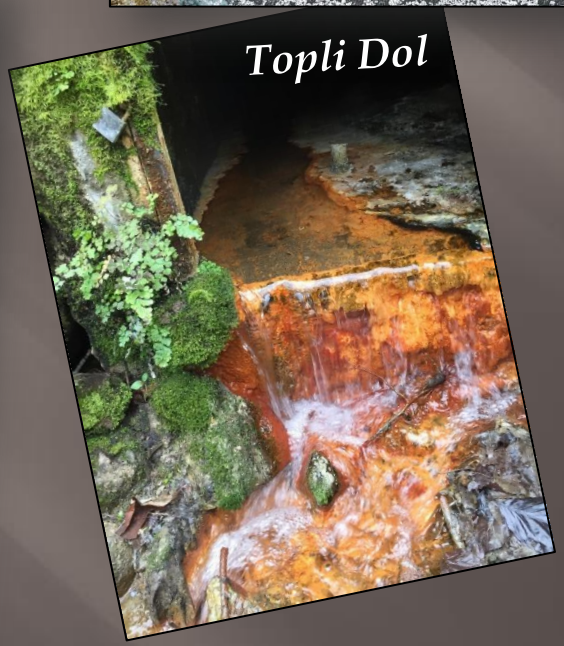


Debarska Banja

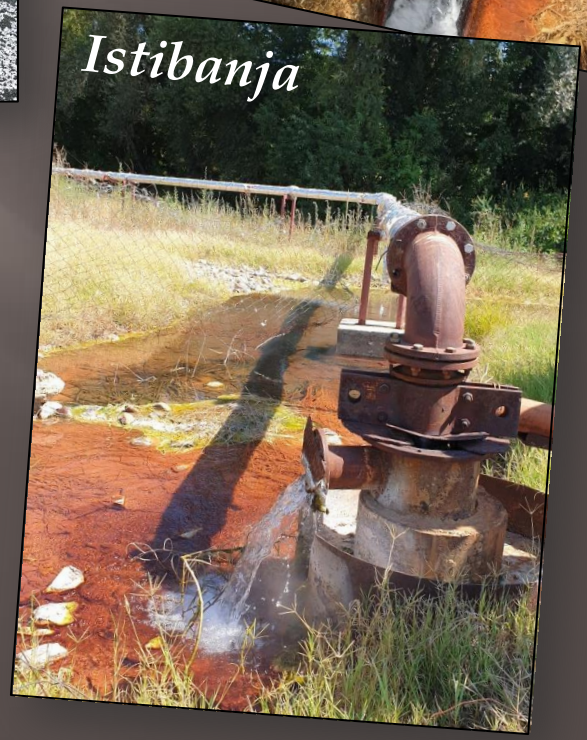
Busemak



Strnovac Banja



Topli Dol



Istibanja

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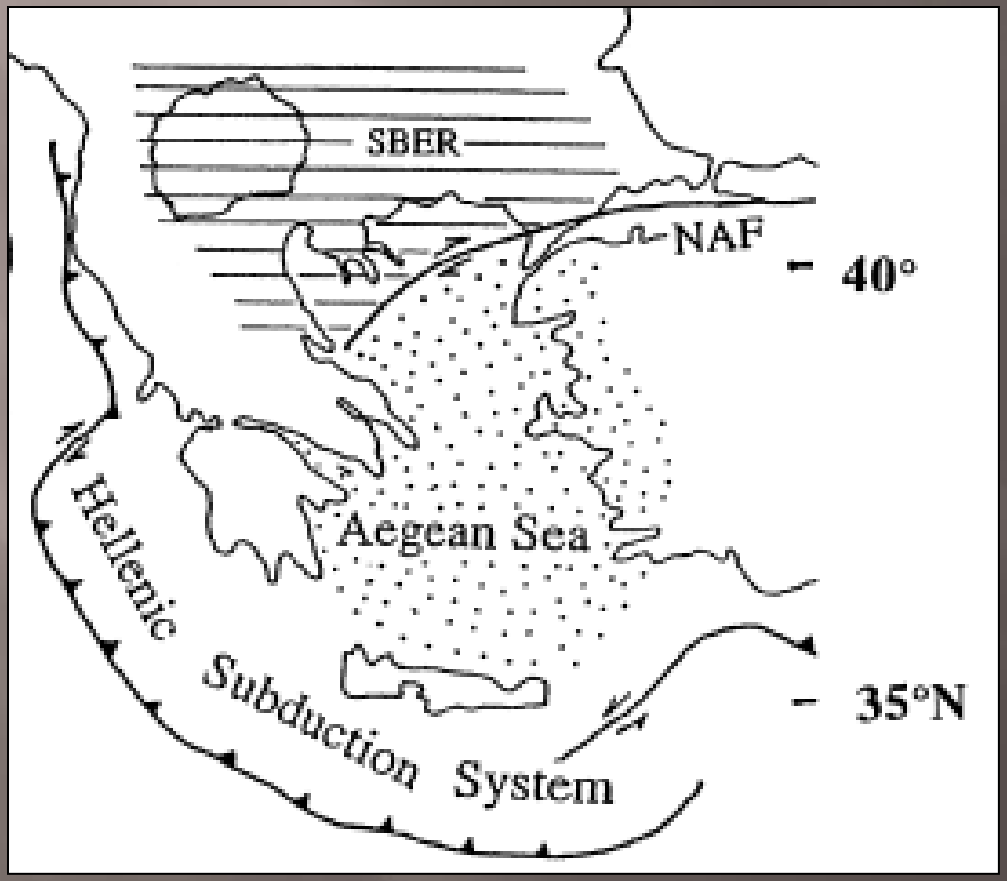
Geodynamic settings

Macedonia is located in the central part of the Balkan Peninsula. The region lies within the Cenozoic Southern Balkan extensional region. The Cenozoic tectonic evolution of Macedonia consists of two periods of extension (Paleogene- Eocene and Neogene-present day), separated by two episodes of SW vergent folding and thrusting (Late Eocene and Late Oligocene-Early Miocene).



Dumurdzanov et al., 2004, 2005

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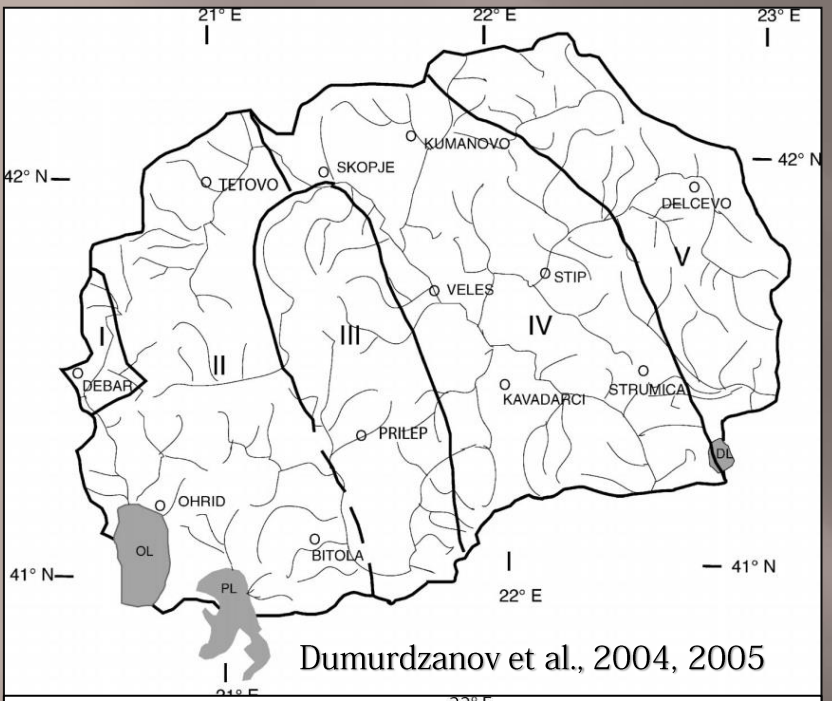
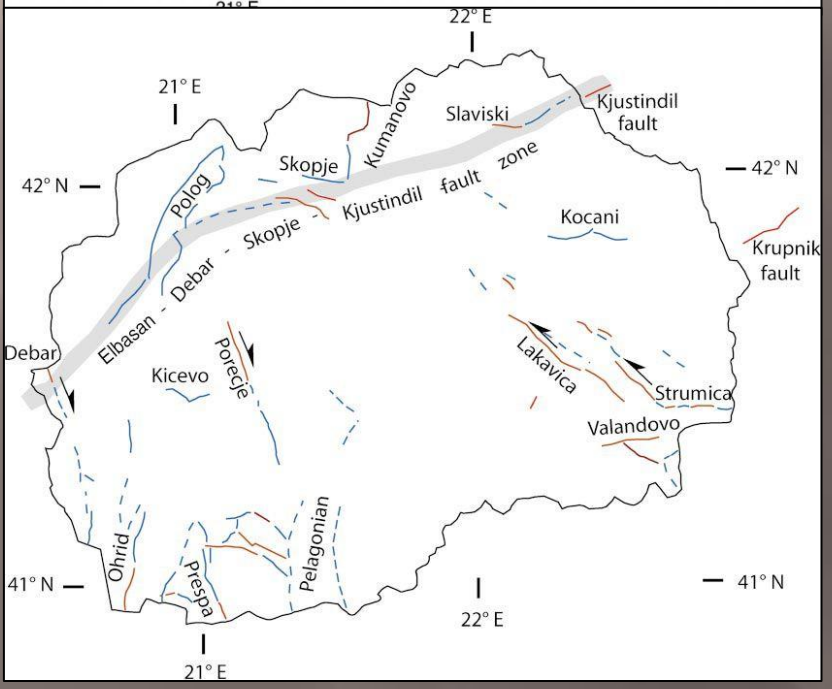
Geodynamic settings



Dumurdzanov et al., 2004, 2005



Macedonian pre-Cenozoic basement consists of five major geotectonic units (from west to east):

(1) **Chukali-Krasta zone** (low-grade metamorphosed sedimentary rocks, Late Cretaceous-Early Tertiary);

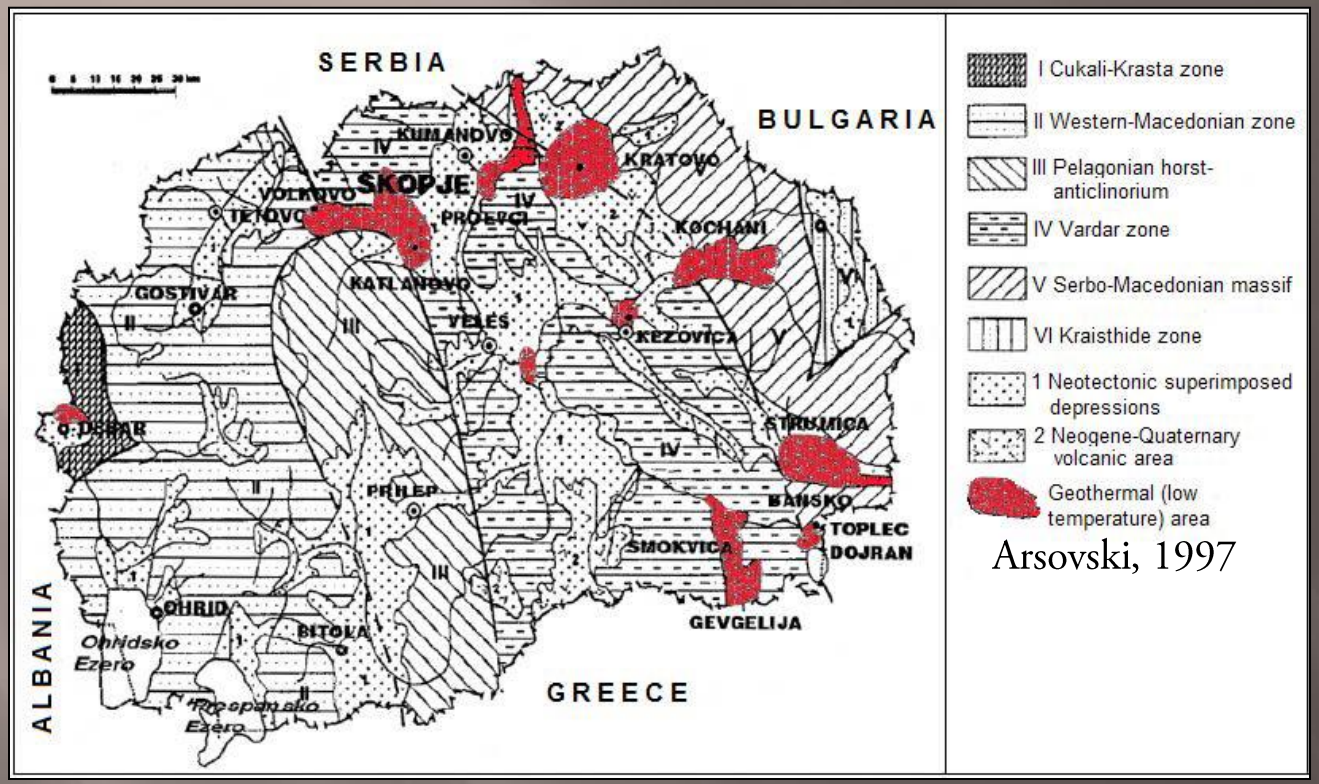
(2) **Western-Macedonian zone** (low-grade to medium-grade metamorphosed Paleozoic sedimentary and igneous rocks and Mesozoic sedimentary rocks);

(3) **Pelagonian massif** (high-grade metamorphosed Precambrian sedimentary rocks);

(4) **Vardar zone** (Paleozoic and Mesozoic metasedimentary rocks and ophiolitic rocks);

(5) **Serbo-Macedonian massif** (Riphean/ Cambrian mafic plutonic and volcanic rocks and Early Paleozoic schist and phyllite).

Geodynamic settings



Seven main low-temperature geothermal fields (up to 75° C)

- Kochani
- Gevgelija
- Debar
- Strumica
- Kumanovo
- Skopje
- Kezhovica

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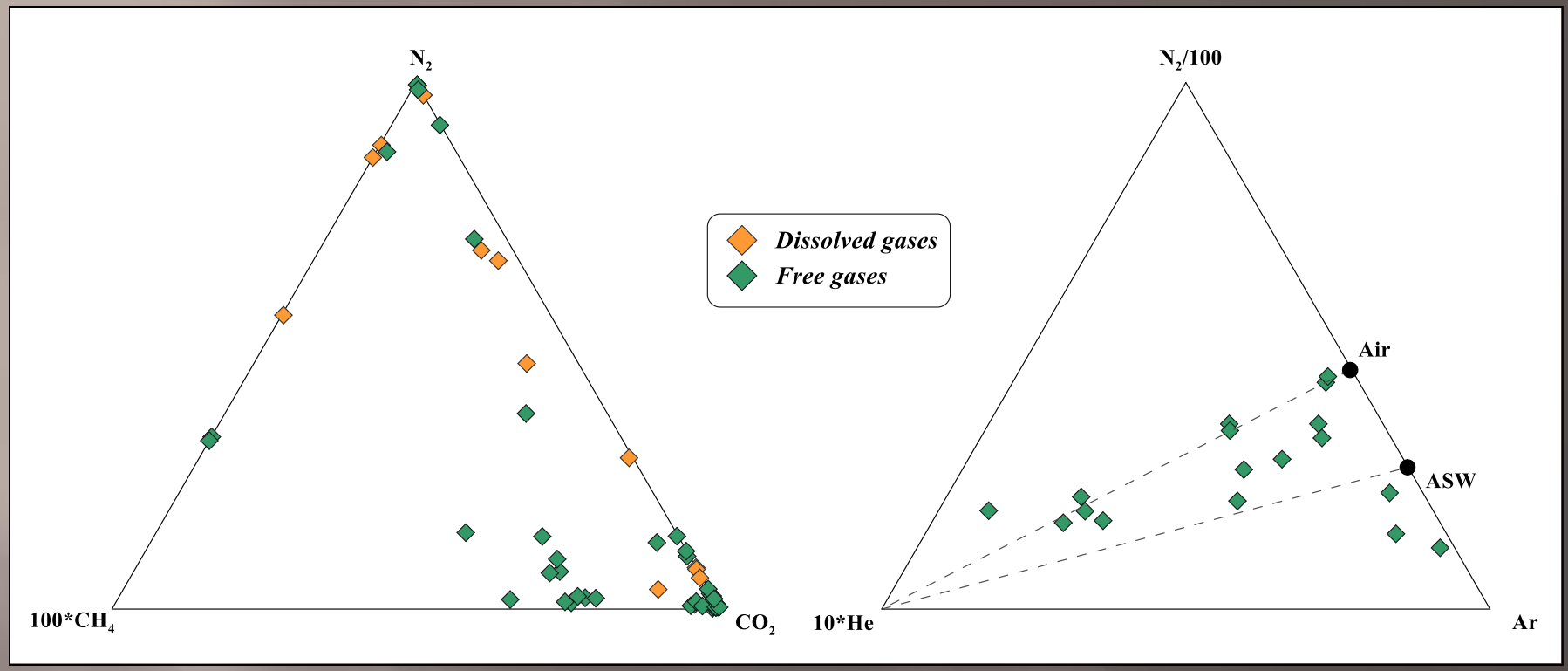
Chemical characterization



Gas samples are dominated by either CO_2 or N_2. Few samples have also significant methane concentrations (up to 20,200 μmol/mol).

Nitrogen and Ar have an atmospheric origin. A few samples which represent residual phases after degassing processes are virtually enriched in Ar due to its higher solubility. Helium shows strong geogenic contribution (either crustal or mantle).

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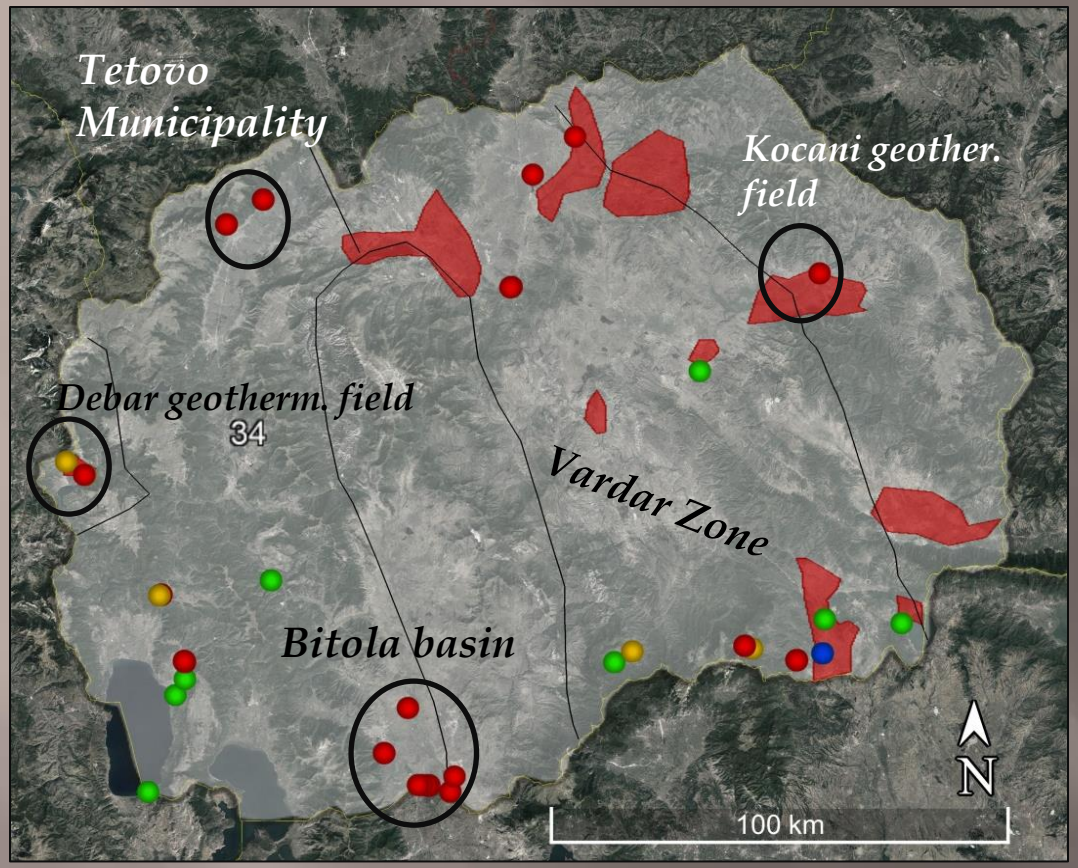
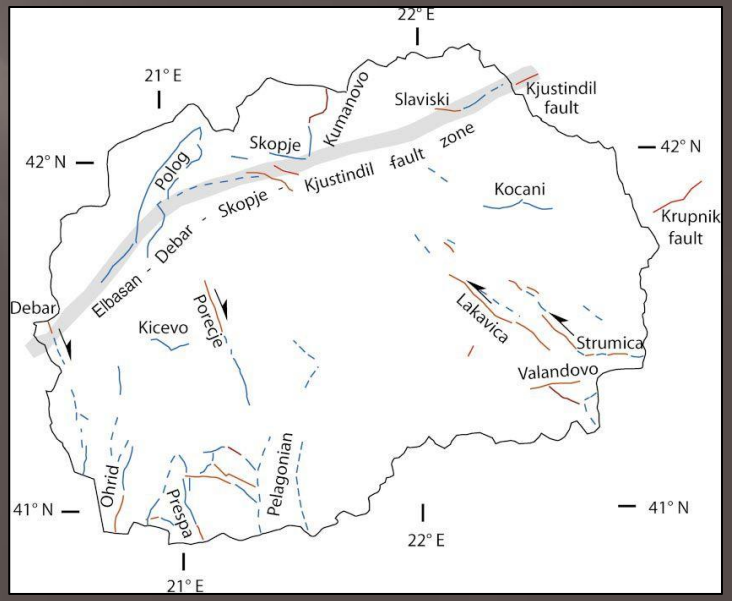
Chemical characterization



CO_2 (μ mol/mol)

- < 1,000
- 1,000 – 210,000
- 210,000 – 810,000
- > 810,000



N_2 varies between 1,300 and 989,000 μ mol/mol, whilst CH_4 arrives up to 20,200 μ mol/mol.

CO_2 ranges from 112 to 1,000,000 μ mol/mol. The highest values are found along mainly major fault lines

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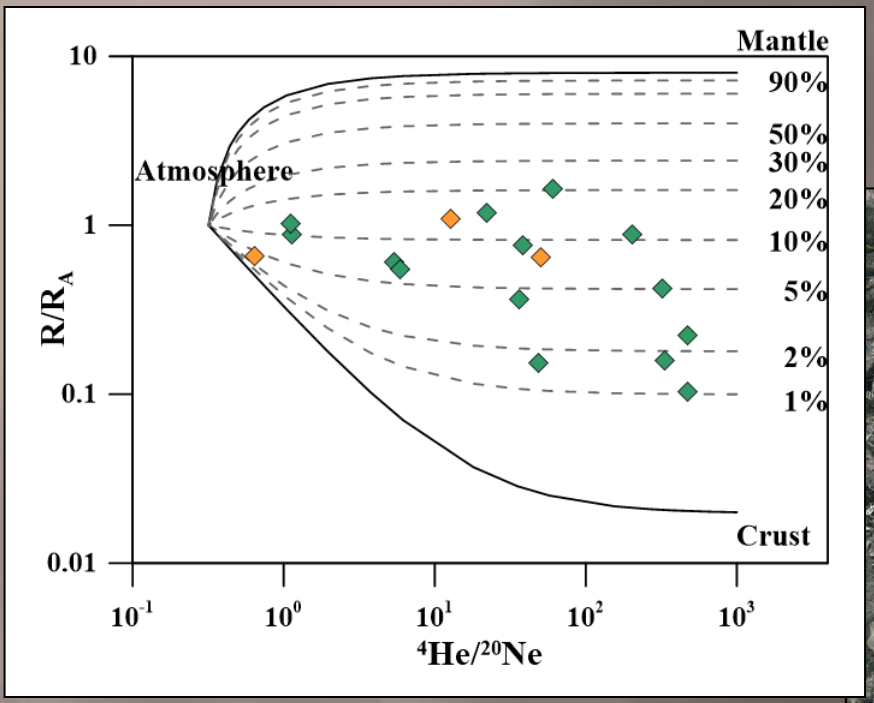
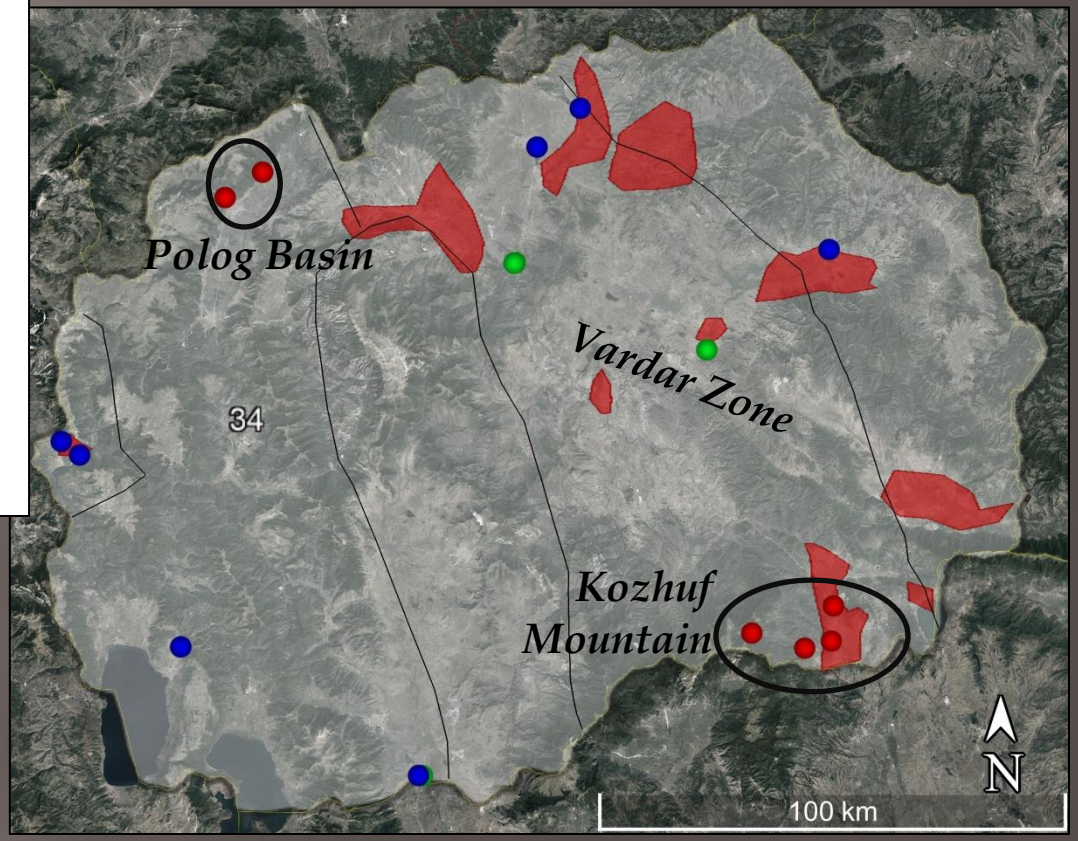
Isotope characterization

Helium shows a prevailing crustal source (R/Ra from 0.1 to 1.6), but a significant mantle contribution (up to 20%) is also present in some samples.





Mantle He (%)

< 5 5 – 10 > 10

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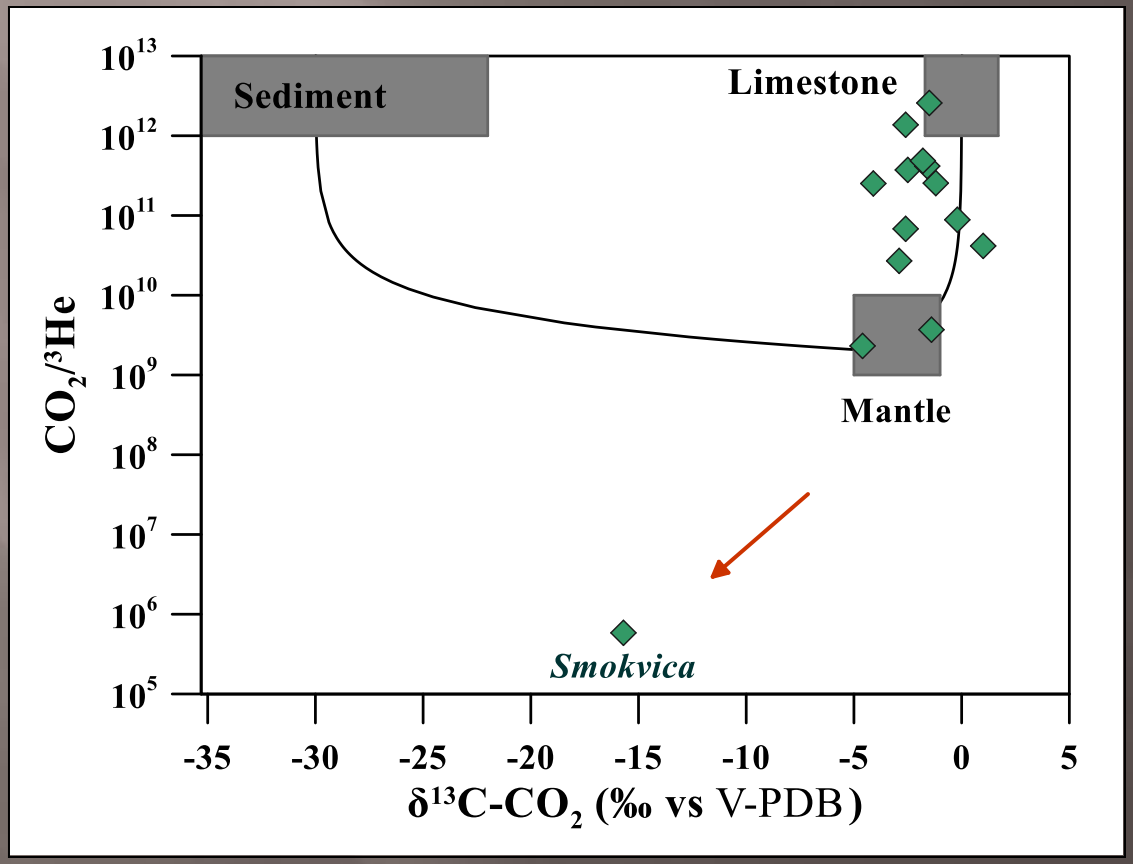
Isotope characterization

δ^{13}C-CO_2 ranges from -15.7 to 1 ‰ vs. V-PDB. Similar to helium, CO_2 has a mainly crustal origin, but the $CO_2/^3He$ ratio indicates a significant mantle contribution at some samples (e.g. Debar, Istibanja). The sample of Smokvica is likely affected by extreme loss (and isotope fractionation) of CO_2 due to dissolution processes.



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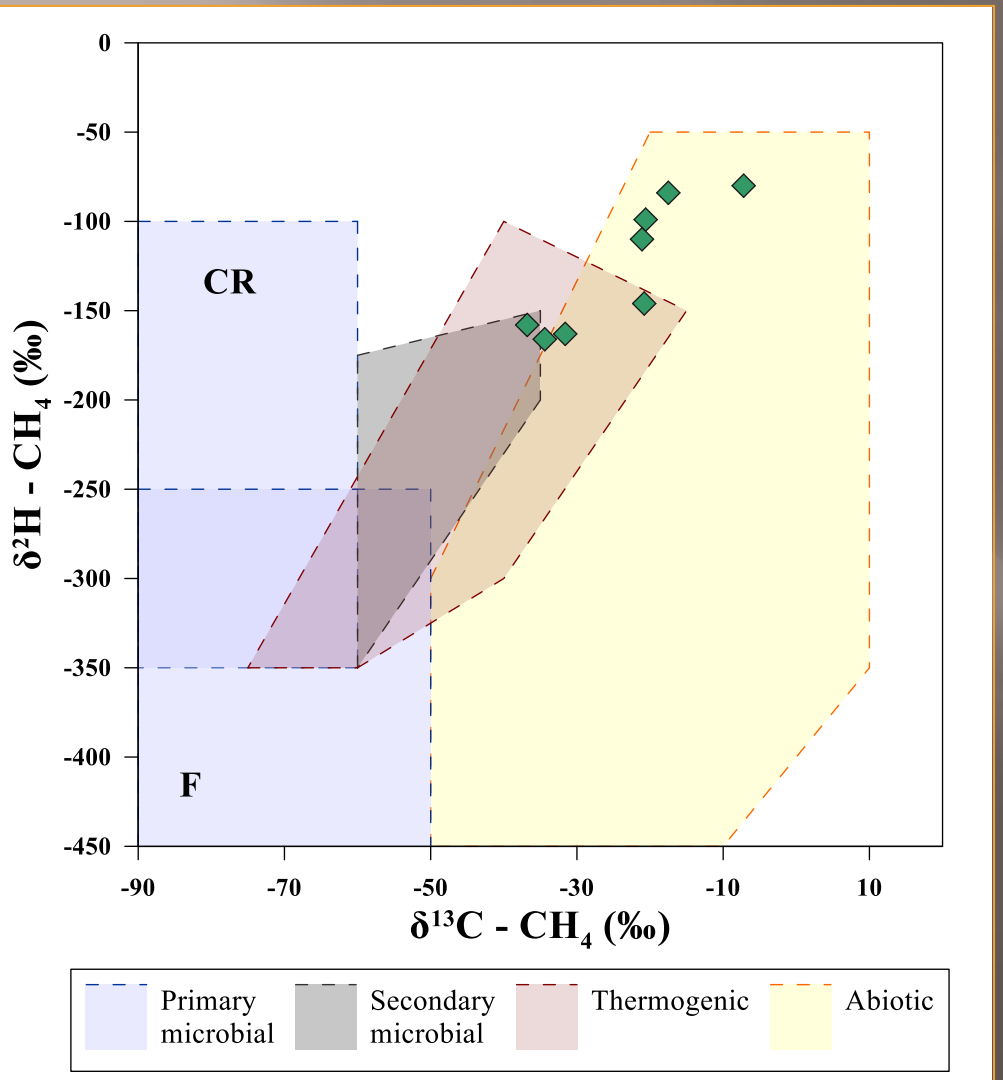
Isotope characterization



Regarding the isotope composition of methane:

δ^{13}C-CH_4 ranges from -36.8 to -4.1 ‰ vs. V-PDB, whereas δ^{2}D-CH_4 varies between -166 and -80 ‰ vs. V-SMOW.

The most negative values indicate a thermogenic origin for methane. The more positive may be related to abiotic methane generation (geothermal or by serpentinization processes) or the result of secondary oxidation processes.

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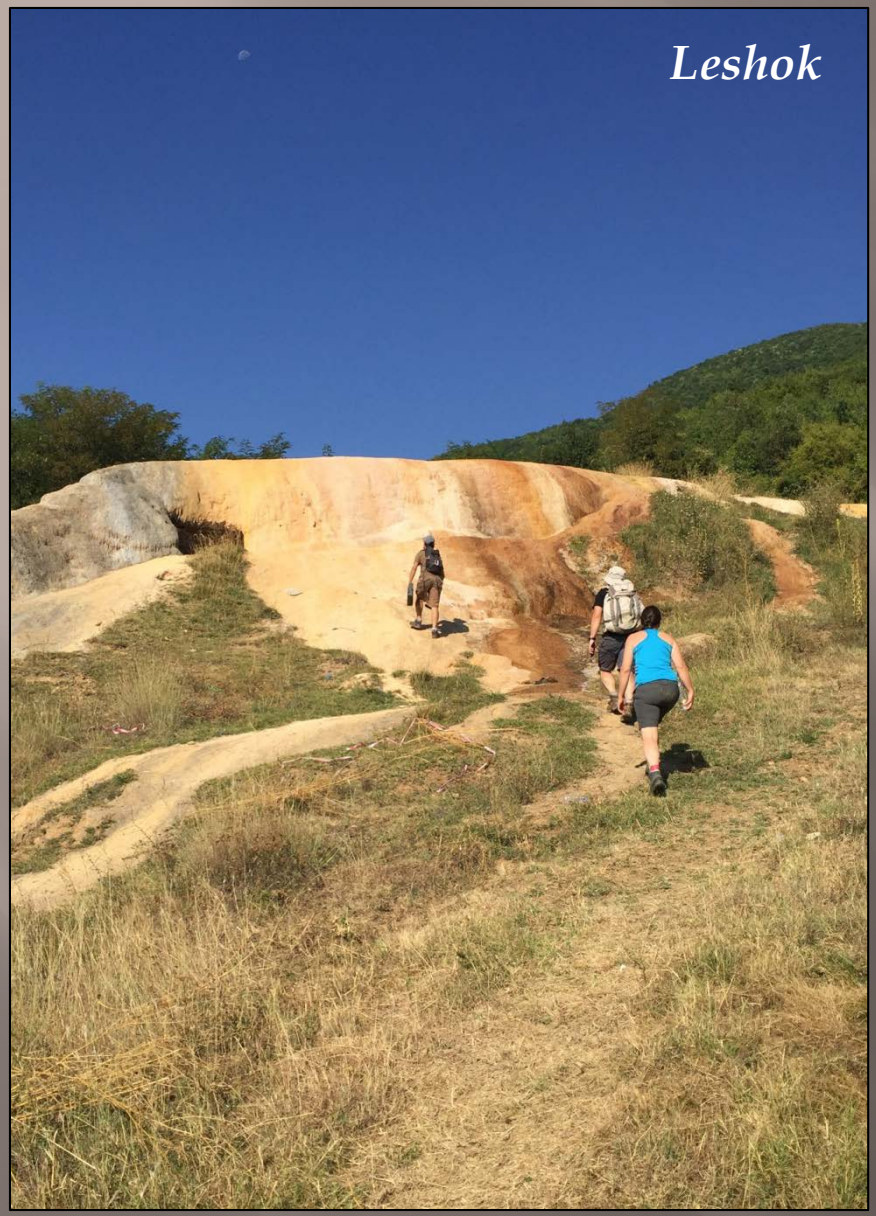

Conclusions

The territory of the Republic of North Macedonia, as most of the Balkan Peninsula, is geodynamically very active. It is therefore not surprising to find many CO_2-dominated gas emissions while only few gas manifestations are dominated by N_2. Coherently to the fact that no hydrocarbon prone area is present in the country, CH_4 seems to play only a secondary role.

Although most of the released gases have a crustal origin, a small but significant (10 - 20%) mantle contribution can be recognised in few sites.

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Help during field sampling is kindly acknowledged

На здравје!

(Cheers)

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