Geochemistry of ancient estuarine deposits on the example of pokurskaya suit sediments (West Siberia)

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An object of study is the fragment of the pokurskaya suit (upper cenomanian) situated in the axial part of the West Siberian sediment pool (J_1-Pg) in the zone of changing sea facies to land ones. Geochemical regime of accumulating the sediments (precipitation) of the local estuarine basin was studied. Within the cut studied, there are four rock complexes fixing two transgressive cycles. First of them consolidates the beds (пласты) PK2 and PK1-2, and second one consolidates beds PK1 and K (turonian). At the same time PK1, PK2, PK1-2 fix (set) estuarine facies, whereas K sets shelf ones. The pattern of distribution of $Na_2O+K_2O)/Al_2O_3$, Mn/U, Sr/Ba, Ce/Ce*, Ti/Zr, Fe/Mn let us mark out eight geochemical cycles within the estuarine cut. Maximum values are $(Na_2O+K_2O)/Al_2O_3$, Sr/Ba, Mn/U that indicates high activity of P_2O_5 and sets local peaks of the upwelling.

Lateral geochemical variability of sediments demonstrates their facial conditions. Thus, sediments of the main channel are characterized by high ratios of Mn/U (over 200), Ce/Ce* (1,2-1,45), Ti/Zr (0,04-0,86), and low content of Sr/Ba (0,23-0,13).

Sediments of the rising tide-low tide zone of the mouth differs from the channel zone by lower contents of Ce/Ce* (1,05-1,10), Mn/U (90-120), and higher content of Sr/Ba (up to 0,30).

The rocks formed in “bor” lagoons are diagnosed using parameter values, which show increasing of Sr/Ba (0,26-0,43), relative stability Ce/Ce* (0,99-1,02), and abrupt change of Fe/Mn (38-84).

Variety of coefficients Sr/Ba (0,28-0,32), Fe/Mn (44,9-35,1), and dispersion Ti/Zr (0,01-0,04) determine facial conditions of the coastal-sea zone.

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Multi-observable thermochemical tomography: A new framework in integrated studies of the lithosphere

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Current knowledge of the present-day thermochemical structure of the lithosphere and upper mantle essentially derives from four independent sources: i) gravity field and thermal modelling, ii) modelling of --different-- seismic data, iii) magnetotelluric studies, and iv) thermobarometric and geochemical data from exhumed mantle samples. Unfortunately, significant discrepancies and/or inconsistencies in predictions between these sources are still the rule rather than the exception, which leads to a lack of confidence in our knowledge of important features of the lithosphere and upper mantle. Moreover, thorough analyses of uncertainties and sensitivities within and between these methods are often neglected, which further exacerbates the problem.

In this talk, I will present a new thermodynamically-constrained multi-observable probabilistic inversion method, particularly designed for high-resolution (regional) studies of the present-day thermochemical structure of the lithosphere and upper mantle. The key aspects of the method are: (a) it exploits the increasing amount and quality of geophysical datasets; (b) it combines multiple geophysical observables with different sensitivities to deep/shallow, thermal/compositional anomalies into a single thermodynamic-geophysical framework; (c) it uses a general probabilistic (Bayesian) formulation to appraise the data; (d) no initial model is needed; (e) a priori compositional information relies on robust statistical analyses of a large database of natural mantle samples; and (f) it provides a natural platform to estimate realistic uncertainties. Assembling this “large” problem required a collaborative effort between thermodynamicists, mineral physicists, geophysicists and geochemists, and marks the first step towards real multi-observable thermochemical tomography studies of the Earth (as opposed to traditional seismic tomography). I will present results for both synthetic and real case studies, which serve to highlight the advantages and limitations of this approach.

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