**Controls of bulk petroleum compositions in conventional and unconventional petroleum systems**

Over the past two decades we have used PhaseKinetics (compositional kinetic approach using the MSSV pyrolysis of low maturity source rocks followed by PVT-modelling) to successfully predict bulk petroleum composition and physical state (GOR, number of phases, saturation pressure) in conventional plays. We will begin the webinar by briefly presenting a recent case study from the Australian NW Shelf to illustrate the model’s utility for the explorationist.

We then use an example from the WCSB to illustrate how petroleum asphaltenes (from Leduc crude oil) can be used as proxies for the generative (Duvernay) source. Initially appearing to be of only academic interest, source asphaltenes are compositionally different from petroleum asphaltenes, but ultra-high resolution mass spectrometry has now shown that fractionation during expulsion plays a key role in bringing about this difference, and that the maturity level at which expulsion occurs can be readily deciphered from the diverging NSO-compound compositions. Such information can be fed back to petroleum system models, adding value for conventional exploration.

Moving on to unconventionals, we demonstrate for key plays from North and South America, with a focus on NSO-compounds, how fractionation drastically alters petroleum composition and physical properties on its way from source to sink within shales and from the shale to production facilities. We have developed a method to allocate produced oil volumes to individual reservoirs using a chemostatistical approach based on the full NSO-compounds inventory. Fractionated and mixed oils can be unmixed and quantitatively assigned to the bitumen extracts of individual known and unknown shale end-members, a method certainly applicable for conventional plays.

As regards fluid property prediction in unconventional settings it is important to note that the in-situ hydrocarbons are dominated by those generated most recently, and do not represent a cumulative composition. The PhaseSnapShot instantaneous charge methodology, utilising mature sample pyrolysates, addresses this issue. Secondly, the produced fluids are highly fractionated with respect to the dispersed in-situ fluids. Whereas in-situ fluids consist of hydrocarbons, resins, and asphaltenes in proportions governed by organic matter type, maturity, and retention behaviour, the produced fluids are highly enriched in hydrocarbons and low polarity NSO compounds, and show a strongly enhanced GOR. Tuning the in-situ composition phase envelopes from PhaseSnapShots using GOR and PVT data from engineering reports on produced fluids allows the preferential retention of higher molecular weight compounds (HCs; NSOs) as well as a preferential production of gaseous hydrocarbons (this does not mean phase separation) to be quantified.

**Short bio:**

Nicolaj Mahlstedt studied Applied Geosciences and holds a Ph.D. from the Technical University of Berlin. Since 2013 he is a Petroleum System Analyst at GEOS4, a service provider specializing in predicting bulk petroleum compositions in conventional and unconventional plays using compositional kinetic modelling and PVT. He is also active as a guest scientist in the Organic Geochemistry group at GFZ German Research Centre for Geosciences, Potsdam, Germany.