Raman spectroscopic analysis of heterogeneous carbonaceous matter in the 2.0 Ga Zaonega Fm, Karelia, Russia

Y. QU[1]*, M.A. VAN ZUILEN[1,2] AND A. LEPLAND[3]

[1]Centre for Geobiology, University of Bergen, Allegaten 41, 5007, Bergen, Norway (*correspondence: Yuangao.Qu@geo.uib.no)
[2]Equipe Geobiosphere, Institut de Physique du Globe - Sorbonne Paris Cité, Université Paris Diderot, CNRS, 1 rue Jussieu, 75238 Paris cedex 5, France (vanzuilen@ipgp.fr)
[3]Geological Survey of Norway, Leiv Eirikssons vei 39, 7491 Trondheim, Norway (Aivo.Lepland@NGU.NO)

Carbonaceous matter in sediments is gradually matured during metamorphism, as increased temperature causes structurally disordered organic molecules to rearrange themselves progressively into crystalline graphite. Raman spectroscopy is commonly used to describe the degree of this transformation, since the relative band intensities at 1350 cm-1 (D1) and at 1580 cm-1 (G) can be directly related to the defect-bound crystal domain size of graphitic crystallites. Intensity-based (R1) and especially area-based (R2) band ratios of carbonaceous matter have therefore been used as reliable indicators for the metamorphic grade that a rock has experienced.

The 2.0 Ga old Zaonega Formation in Karelia, Russia, contains sediments that are highly enriched in organic carbon. They represent the first known record of oil generation and migration on Earth, and form a key target for drill-core-based studies on the evolution of life during the Archean-Paleoproterozoic transition period. Carbonaceous matter consisting of residual kerogen and pyrobitumen throughout the succession has experienced local contact-metamorphism caused by gabbroic sills and lava flows, regional greenschist-facies metamorphism, and migration in silicate saturated fluid systems. This complex geologic history prevents simple straightforward interpretation of original isotopic ($\delta^{13}C$) and chemical characteristics of carbonaceous matter, and requires an *in situ* tool such as Raman spectroscopy to distinguish between variously altered carbonaceous fractions and small scale heterogeneities.

Here we report the variation in Raman spectral indicators R1 and R2 of carbonaceous matter throughout a 7 m long drill-core section that represents the upper contact zone of a gabbroic sill. Considerable heterogeneity in both R1 and R2 on a small spatial scale, indicates that factors other than temperature - such as organic precursor material, mineral matrix, and local variation in stress and strain - have influenced the overall process of graphitization. The implications for Raman-based geothermometry on complex metamorphic terrains will be discussed.

Estimating aerosol forcings using the MACC aerosol reanalysis

JOHANNES QUAAS[1]* AND NICOLAS BELLOUIN[2]

[1]Institute for Meteorology, University of Leipzig, Stephanstr. 3, D-04103 Leipzig, Germany (*correspondence: johannes.quaas@uni-leipzig.de)
[2]Hadley Centre, Met Office, FitzRoy Road, Exeter EX1 3PB, United Kingdom (nicolas.bellouin@metoffice.gov.uk)

In the EU-funded project ‘Monitoring Atmospheric Composition and Climate’ (MACC), MODIS satellite retrievals of aerosol optical depth (AOD) are assimilated into the IFS global atmospheric model enhanced by an aerosol module, and used for quasi-operational numerical weather forecasts. This MACC aerosol reanalysis yields a 3D field of concentrations of different aerosol components consistent with the MODIS AOD retrievals, along with the reanalysis of meteorological fields, and cloud and radiation distributions as computed by the model. This new dataset provides a unique opportunity to estimate aerosol climate forcings. On the basis of the method by Bellouin *et al.* [1] and Quaas *et al.* [2], where the aerosol radiative forcings have been derived from satellite data, we develop an improved method using this new dataset. Preliminary results show a global annual (year 2003) mean radiative forcing by the aerosol direct effect of -0.5 Wm^{-2}, and an indirect effect (first indirect effect or Twomey effect) of -0.3 Wm^{-2}. The product now also allows for a detailed analysis of the spatial and temporal variability of aerosol forcings.

[1] Bellouin *et al.* (2005) *Nature* **438**, 1138–1141. [2] Quaas *et al.* (2008) *J. Geophys. Res.* **113**, D05204.