Understanding O_2-deficient and CO_2-enriched gas production and migration in the subsurface above a coal post-mining area through *in situ* gas monitoring and modelling

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Context

INERIS works for 3 years on the characterization of O_2-deficient and CO_2-enriched gas production and migration processes above a former coal mining area where gas emissions occur at surface and which is close to a peat bog. The main objectives of this work were to determine the composition and origin of the emitted gas and the dynamics of its migration from the subsurface rock strata to the surface.

Study and results

In 2009, analyses (gas concentrations and $\delta^{13}C$ isotopic signatures) were performed during spells of low barometric pressure and gas flux was determined at surface of the studied area. Analyses were performed on field and in lab. Results have shown that emitted gas cannot be from mine or peat origin, respectively because it does not contain methane but CO_2 and because isotopic signatures do not match.

In 2010, a continuous gas monitoring was setup on field during a 6-month period. $\delta^{13}C$ isotopic signature of CO_2 was also monitored on field and gas/water samples have been collected for further analyses in lab. Results have shown that CO_2 emissions dynamics is linked to barometric pressure changes. We have also demonstrated that emitted gas cannot come from groundwater degassing, because dissolved gas quantity is not sufficient to explain gas concentrations measured at surface. That means that CO_2 is produced above the water table, in the saturated zone. A modelling study has shown that pyrite oxidation associated to carbonate dissolution is probably the reaction scheme that produces CO_2. Then main fractures lead CO_2 towards surface.

Scope of the presentation

The presentation will detail the methodological and metrological approaches that have been used in this study to characterize gas production and migration in the subsurface above a coal post-mining area. We will present our results, discuss the different gas origins that have been examined, describe migration processes and explain our conclusions.

Tracing crustal recycling in the mantle sources of the Cape Verde and Azores plumes using stable Mo isotope measurements

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Constraining the role of crustal recycling is key to understanding the causes of mantle heterogeneity. In the past, radiogenic isotopes (Sr, Nd, Pb and Hf) and stable isotopes (Li) have been used as tracers to study this process, but none yield unequivocal signatures of recycling. In this study, we investigate the Mo stable isotope system as a new, potential tracer of recycled crust. Recent studies (see summary in [1] and unpublished data in [2-3]) have shown that the isotopic composition of Mo becomes fractionated in low temperature environments, with a notable offset of $\delta^{97}Mo$ between seawater (+1.6‰) and Mn-crust (-0.5‰). Mo isotopes could therefore be a potential tracer for deep mantle recycling of crustal components that have experienced low-temperature alteration on the Earth's surface. Literature $\delta^{97}Mo$ values of igneous rocks define a narrow range of $\delta^{97}Mo$ (-0.06 to +0.17 ‰) yet the uncertainties related to the analytical methods used so far (2S.D. < 0.1‰) do not allow much resolution of primary signature within this small range. Here we present Mo isotopes in oceanic island basalts from Cape Verde Islands and Azores archipelago that were determined using a newly-devised, higher-precision MC-ICPMS method (2S.D. is 0.03‰). Systematic variations of $\delta^{97}Mo$ values with key trace element ratios (i.e. Pr/Mo) indicate that the mantle sources of the Cape Verde and Azores contain various amounts of components that must have experienced alteration on the Earth surface in the past.

[1] Anbar (2004) *Rev. Min. Geochem.* **55**, *429–454*. [2] Vils *et al.* (2011) *this volumn*. [3] Freymuth *et al.* (2011) *this volume*.