Rn in water detection by LSC – sample volume optimization

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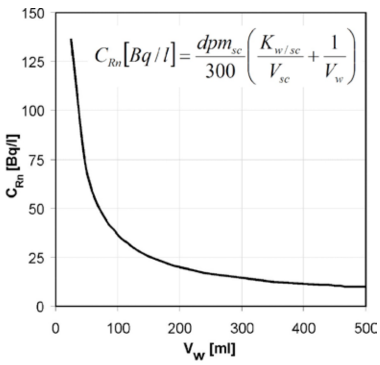
Radon (^{222}Rn) is, amongst the noble gases, of particular interest as tracer in groundwater / surface water interaction studies. In related applications radon-in-water concentrations can be detected either directly in the field by using a mobile radon-in-gas monitor or after a water sampling campaign by liquid scintillation counting (LSC) in the laboratory.

If LSC is applied the radon has to be transferred from the water sample of a certain volume V_w [l] into the scintillation cocktail of the volume V_{sc} [l]. Whereas V_{sc} is preset by the size of the LSC vials (usually 20 ml) V_w is not specified. Aim of the presented study is an optimization of V_w.

The equation given in the figure allows calculating the ^{222}Rn concentration that was originally present in the water sample C_{Rn} [Bq/l] based on V_{sc} and V_w, on the water/cocktail partition coefficient for radon $K_{w/sc}$ and on the dpm value detected in the cocktail dpm_{sc}. The equation is based on the assumption that dpm_{sc} represents the total dpm of ^{222}Rn and its four short-lived progeny (after 3 h equilibration time), i.e. of five radionuclides in decay equilibrium.



Plotting the equation for an exemplary dpm_{sc} value (e.g. 1000), for a $K_{w/sc}$ value of 0.019 (valid for 21°C) and for varying values for V_w and V_{sc} results in a 3D image. Setting V_{sc} to 20 ml (the cocktail volume that is usually applied) results in the 2D plot for C_{Rn}/V_w shown in the diagram. It becomes obvious that the gradient of the function flattens significantly if V_w increases over about 350 ml. That implies that an increase of the water sample volume over about 350 ml does *not* result in significantly higher counting rates (and neither in better counting statistics). On the other hand, a water volume that is significantly smaller than about 250 ml results in a significantly smaller radon concentration in the cocktail and hence in poorer counting statistics. Thus, water sample volumes of about 250 - 350 ml should be chosen if 20 ml vials are applied for radon-in-water detection by LSC.

Transformational faulting in high pressure polymorphs – two case studies in quartz and olivine

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Intermediate and deep focus earthquakes (100 -700 km) occur in a pressure and temperature regime where rocks are expected to deform plastically. The idea that they may be triggered by phase transformations in cold subducting lithosphere is appealing. However, the relationship between phase transformation and faulting remains unclear.

Coesite has been recognized as a reliable marker of ultrahigh-pressure (UHP) metamorphic environments in continental collision zones. Recent careful relocation of subduction-zone earthquakes have also shown that at depths of 100–250 km, seismicity occurs in the uppermost part of the slab, where the former oceanic crust has already been converted to eclogite, In the mantle transition zone, olivine undergoes two phase transformations while deep focus earthquakes locate inside the coldest part of slab, where metastable olivine bodies have sometimes been identified.

Here, we provide experimental evidence that, under differential stress at high pressure and temperature conditions ($\Delta\sigma=2GPa$, $P=2\text{-}5GPa$ and $T=1150\pm50K$), shear fractures nucleate and propagate at the onset of the olivine -> spinel transition in the Mg_2GeO_4 analogue system. Similar observations were performed for quartz -> coesite ($\Delta\sigma=4GPa$, $P=3\text{-}4GPa$ and $T=1300\pm50K$) in samples of Arkansas novaculite. In both cases, fracture propagation is sufficiently rapid to radiate energy in the form of intense acoustic emissions. These follow the Gutenberg-Richter law over 4 orders of moment magnitudes and like intermediate and deep-focus earthquakes, require no volumetric strain.

Microstructural analysis shows the development of macroscopic faults, filled with a gouge composed exclusively of the HP polymorph (spinel or coesite). Within the gouge, the material is so fine (1-50 nm) that diffusion accommodated grain boundary sliding may have provided a mechanism viable at “coseismic” strain rates (>10^4 s^{-1}). Our results seem to indicate as a rule that HP polymorphic transformations are mechanically unstable under stress, simply because they are exothermic and induce large negative ΔV. This clearly opens the prospects of revisiting a large number of phase transitions to assess their role in the triggering of deep seismicity.

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