He and Ne ratios in Icelandic basalts

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New ${}^3He/{}^4He$ ratios from 9 olivine separates from the Reykjanes Peninsula, Iceland, range from 14 ±1 to 23 ±2 Ra. New neon isotopic ratios from 6 of these separates are MORB-like. The new and published neon isotopic data [1-3] show Icelandic neon ratios range from MORB-like to solar-like. The possible origins of this significant neon isotopic heterogeneity are evaluated in terms of two models [e.g., 4].

One is the "plume source model," described using the ${}^3He/{}^{22}Ne$ ratio calculated from the measured isotopic ratios (see equation). A very small range in ${}^3He/{}^{22}Ne_{calc}$ ratios could imply the plume source (lower mantle/core) is relatively homogeneous. In contrast, a large range in ${}^3He/{}^{22}Ne_{calc}$ implies either the plume source is heterogeneous, or that the alternative model applies, in which binary mixing of the plume and MORB derived gases produces a range in ${}^3He/{}^{22}Ne_{calc}$ ratios in the mixture.

$${}^3He/{}^{22}Ne_{calc}=({}^{21}Ne^*/{}^{22}Ne)\mathbf{(}{}^4He/{}^{21}Ne^*\mathbf{)(}1/({}^4He/{}^3He_{obs}-{}^4He/{}^3He_{init}))$$

Calculation of the mantle source ${}^3He/{}^{22}Ne$ ratio depends on two key factors. One is the assumed value of the initial mantle ${}^{20}Ne/{}^{22}Ne$ ratio used for atmospheric correction of the measured neon ratios. This value has been argued to be equal either to the solar wind ratio (13.8), or the Ne-B ratio (12.5) [5, 6]. Justification for using the solar ${}^{20}Ne/{}^{22}Ne$ ratio will be discussed. Using the solar ${}^{20}Ne/{}^{22}Ne$ ratio gives a larger range in (${}^{21}Ne/{}^{22}Ne_{corr}$ - ${}^{21}Ne/{}^{22}Ne_{solar}$)=${}^{21}Ne^*/{}^{22}Ne$, hence a larger range in ${}^3He/{}^{22}Ne_{calc}$ ratios. Icelandic ${}^3He/{}^{22}Ne_{calc}$ values range from close to the solar nebula ratio (1.9) [7, 8] to well in excess of the MORB popping rock ratio (7.3) [9]. Consequently, $M/P=({}^3He/{}^{22}Ne_{calc})_{MORB}/({}^3He/{}^{22}Ne_{calc})_{PLUME} >> 1$. An M/P ratio >> 1 would seemingly contradict the steady-state mantle model, which involves equal fluxes of ${}^3He$ and ${}^{22}Ne$ from the lower to the upper mantle [10-12].

The second factor is the assumption in the above equation that the ${}^4He/{}^{21}Ne^*$ ratio is equal to the mantle production ratio. This is usually a good assumption, but can be violated by recent He/Ne fractionation and mixing.

The alternative, binary mixing model, involves a large range in $R=({}^3He/{}^{22}Ne)_{MORB}/({}^3He/{}^{22}Ne)_{PLUME}$ such that R >> M/P. If recent elemental fractionation and mixing produces a large range in R-values, the ${}^4He/{}^{21}Ne^*$ may differ from the production ratio.

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Investigation of damage formation around wellbores using reactive transport modeling

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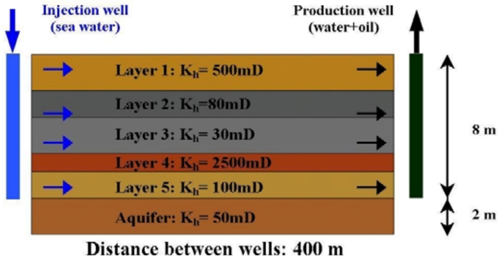
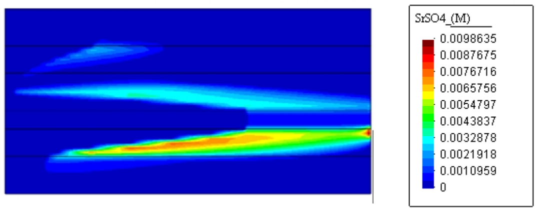
Description of the problem

In offshore operations, sulfate scale may form when seawater is injected into the formation during waterflooding operations. When seawater (rich in sulfate and poor in Ca^{2+}, Sr^{2+} and Ba^{2+}) mixes with a formation porewater containing cations Sr^{2+} and Ba^{2+}, sulfate minerals will precipitate. Scale deposition restricts the flow of fluids through the formation (matrix damage), resulting in a loss of permeability.

A fully coupled formulation (Guimarães, 2002) combining reactive transport and an existing thermo-hydro-mechanical code was used to investigate this problem. Since the fluid mixture is quite concentrated, it was adopted a virial model (Yuan and Todd, 1991) to calculate activity coefficients for the Na-Ca-Ba-Sr-Mg-SO_4-Cl system extrapolated to typical reservoir temperatures and pressures.

In the simulation, a multiphase porous medium was considered containing water and oil. A stratified formation with large variations of permeability was assumed. The figures show the geometry of the problem and, as an example of the results obtained, the distribution of $SrSO_4$ mineral at 300 days after the start of the seawater injection. The model is also able to predict the composition of water produced in the well, that frequently causes scale in production tubing.





References

Guimarães L. N., (2002). Ph.D. thesis, Technical University of Catalunya, Spain.

Yuan M. and Todd A., (1991). *SPE Produc. Eng.* **6**. 63-72.