Geophysical Research Abstracts,
Vol. 10, EGU2008-A-00683, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-00683
EGU General Assembly 2008

Verification of underground nuclear testing by atmospheric pumping

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After an underground nuclear explosion radionuclids are injected into the surrounding rock creating an initial contaminant distribution. In the case of fractured permeable media, cyclical changes in atmospheric pressure can draw gaseous species upwards into the surface, establishing a ratcheting pump effect. The resulting advective transport is orders of magnitude more significant than transport by molecular diffusion. In the nineties of the antecedent century the US Department of Energy funded the Non-Proliferation Experiment conducted by Lawrence Livermore National Laboratory to investigate this barometric pumping effect for verifying compliance with respect to the Comprehensive Nuclear Test Ban Treaty. A chemical explosive of about 1 kt TNT-equivalent was detonated in a cavity located 390m deep in the Rainier Mesa, Nevada, in which tracer gas was emplaced. Within this experiment SF_6 was first detected in soil gas samples taken near fault zones after 50 days and ^{3}He after 325 days.

For on-site inspection purposes a deep understanding of the transport mechanism is required to estimate time of arrival of radioxenons as well as its concentration levels. The migration model will be presented.