**Measurements of Radioactivity Equilibrium and Disequilibrium**

**in Oil Scale**

**Sheldon Landsberger,1,\* Christopher Martin,1,2 and Kayla Cockerline1, Joseph Lapka1**

*1University of Texas at Austin, Texas, USA*

*2Los Alamos National Laboratory, New Mexico USA*

\**e-mail: s.landsberger@mail.utexas.edu*

Radioactivity equilibrium and disequilibrium in NORM and TENORM are common phenomena that have been studied for many years both from scientific and radioecology points of view. The study of radioactive waste in the oil and gas exploration field has been very well known for many decades with many published papers. However, little research has been undertaken to study equilibrium and disequilibrium. Since oil scale has the significance presence of high Z elements such as Ba and Sr, along with Fe, gamma ray self-attenuation can seriously underestimate radioactivity measurements especially for low energy photon below 100 keV. The usual gamma ray counting techniques to determine U and Th are very difficult in oil scale. We present results for the complete decay chain of U-238 and Th-232 for those radioisotopes that decay via gamma-rays. We also show results for the determination of U and Th via neutron activation analysis.