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## Multi-element determinations in oil shale and soil samples by instrumental neutron activation analysis

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Oil shale is an organic-rich fine-grained sedimentary rock that has received much attention over the last years as an alternative energy source. The analysis for element distribution in raw shale is highly important for its exploration and processing programs as well as for studying its formation and the dispersion of its potentially toxic elements. In this study, instrumental neutron activation analysis (INAA) procedure was established for the multi-element determinations in oil shale and soil samples from Irati oil shale in São Mateus do Sul, Parana, Brazil. Oil shale from upper and lower layers, retorted and fine shale were ground to a powder and aliquots of each sample and element standards were irradiated for 8 h under a thermal neutron flux of about  $4.0 \times 10^{12} \text{ n cm}^{-2} \text{ s}^{-1}$  of the IEA-R1 nuclear research reactor. After adequate decay times the induced gamma activities were measured using a gamma ray spectrometer. Comparisons made between the results showed higher concentrations of As, Ba, Co, Fe, K, Rb and Zn in shale oil samples than those presented in soil. However concentrations of Br, Cr, Cs, Hf, Sb, Th, U and lanthanide elements present in oil shale samples were lower than in soil or the same order of magnitude. Quality control of analytical results was performed by analyzing two certified reference material NIST

2704 Buffalo River Sediment and IAEA Soil-7, whose results presented good precision and accuracy. These preliminary results demonstrated that INAA can be a useful tool for the evaluation of shale oil element composition.