Synchrotron Radiation in the Earth and Environmental Sciences: Applications to the Petroleum Geosciences

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ABSTRACT

Application of synchrotron radiation in the earth sciences has proved to be extremely beneficial for physical, mineralogical and chemical characterization of complex geologic systems such as 1) micron-scale, crystalline intergrowths, 2) behavior of elements (S, N) and phases (CH_4, CO_2) in geomacromolecules (kerogen, asphaltenes) and fluid inclusions and 3) neoformed low-temperature, semi-amorphous minerals. Primarily, these involve application of synchrotron light in the areas of 1) Synchrotron X-Ray Diffraction, 2) X-Ray Absorption Spectroscopy (XANES/XAFS) and 3) X-Ray Fluorescence (SXRF, Tomography). Third Generation synchrotron sources produce light that is 1) very brilliant, 2) highly collimated and 3) broad spectrum (<1 keV to >40 keV). The availability of highly collimated, high brilliance x-ray beams over such a broad energy range facilitates high spatial resolution spectroscopic and chemical analyses on elements with Z>18 (K- or L-edges) as well as lighter elements (i.e. C, N, O, Na, F, Cl, S, Al, P) at the ppm level.

In 2004 the Canadian Light Source located at the University of Saskatchewan, which is a 3rd Generation Synchrotron research facility, will be operational with some beam lines designed for applications in the geosciences. Here, the focus will be on the fundamentals of synchrotron radiation for geologic studies applicable to the petroleum industry as well as the salient aspects of this facility for these purposes.