Geophysical Research Abstracts,
Vol. 11, EGU2009-6005, 2009
EGU General Assembly 2009

A dedicated dual-energy computer tomograph to work on-board of R/V Mare Nigrum

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A dedicate on-board dual energy computer tomograph able to generate both tomographic and digital radiographic images of unconsolidated sediments cores having a maximum diameter up to 12 cm and a height up to 1 m was designed, built and commissioned. This instrument can be used on-board of the National Institute of Marine Geology and Geo-ecology R/V Mare Nigrum or of any other oceanographic research vessel with minimum adaptations as well on stationary laboratory, provided with an adequate protection against hard X-rays.

The tomograph has a single X-ray generator with a maximum anodic potential of 160 kV and two sets of 200 in-line solid state X-ray detectors separated by a copper shield which allowed obtaining tomographic as well as digital radiographic images depicting the distribution of both density and effective atomic number within investigated objects. The front, low-energy detectors are provided with a CsI scintilator while a cadmium tungstate scintilator covers the high-energy, rear detectors. Image reconstructions are performed by using proprietary software based on the filtered back-projection algorithm.

In tomographic mode, images are displayed on a 400 x 400 pixels grid such that the best the spatial resolution of reconstructed images of the linear attenuation coefficient is about 0.5 mm while in dual-energy mode, when reconstructed images depict the distribution of densities and effective atomic numbers, the spatial resolution varies between 1 to 1.5 mm. The same spatial resolution was obtained also in digital radiographic mode. In this case, the instrument allows obtaining classic radiographies depicting the projection of the linear attenuation coefficient while in the dual-energy mode, the images illustrate both the projection of the effective atomic numbers or of the superficial mass defined as the product between density and thickness. It is worth mentioning that in digital radiography mode a 1 m core is radiographed in less than 2 minutes while in tomographic mode, a section is scanned in less than 20 s.

By using a set of standard samples with well known values of densities and effective atomic numbers we have estimated the precision in calculating the local values of these parameters to 5 % for density and 2% for the effective atomic number.

On cruise conditions, the instruments shown to be robust, versatile and less sensitive to engine vibrations, allowing obtaining both digital radiographies and tomographic images with the same accuracy as in a stationary laboratory. In this way, by its performances and by its ability to work on-board, the tomograph proved to be very useful not only for oceanographic researches but also for any exploratory works performed on open sea.