

## ENVIRONMENTAL RADIONUCLIDES TO ASSIST IN ESTUARINE SEDIMENT TRANSPORT STUDIES

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In sediment transport studies data on grain size compositions are of primary importance for modelling purposes. Normally, in order to obtain the grain size distribution pattern for the area studied, a large amount of sediment cores are to be recovered from the field and their grain sizes are subsequently analysed in the laboratory. Such works are time consuming and fail to be applied particularly for cases when the grain size distribution pattern changes very fast e.g. under abnormal hydrometeorological conditions.

In this paper an alternative approach is proposed making use of in-situ environmental radionuclides (uranium and thorium series and  $^{40}\text{K}$ ) for characterising bed sediment grain size compositions. The observed trend of enrichment of metals (including radioactive ones) in clay minerals relative to sand particles [1] suggests a possible correlation between the gamma background and the relative abundance of fine particles in bed sediment.

The suitability of the proposed approach is demonstrated through experiments carried out at Haiphong estuary area. Increasing siltation of the access channel to Haiphong port, especially along the reach between buoys No 10 and No 16 (Fig. 1) has forced to reduce the freight-carrying capacity of cargo vessels from 10,000 tonnes to 5000-6000 tonnes over the last two decades. A number of radiotracer experiments have been carried out to assist in clarifying the various aspects of siltation in the area [2]. During these experiments the tracking of bed radioactivity background was to be done and one of such background distribution patterns is shown on Fig. 1. The gamma radiation was detected by an immersed 2"x2" NaI(Tl) detector which was dragged at an average speed of 1-1.5  $\text{ms}^{-1}$ . The gamma background and the position of the boat were recorded in every 10 seconds. The average distance between tracking lines was about 150 m.

Sediment cores were recovered at positions marked by triangles in Fig. 1. The grain size composition was determined by sieving and by Stock law method. The regression of  $d_{50}$  values against gamma counts ( $x$ ) yields the following linear equation:

$$d_{50} (\mu\text{m}) = -0.17x + 183, \quad R^2 = 0.92$$

The evidence of the grain size dependence of gamma background was supported by measuring the specific activities of environmental isotopes in the various size fractions using a low background gamma spectrometer. The results show that fine particles of less than 10  $\mu\text{m}$  are enriched in  $^{40}\text{K}$  and isotopes of uranium and thorium series by a factors of 2-3 relative to coarse sand particles.  $^{137}\text{Cs}$  is attached mainly on

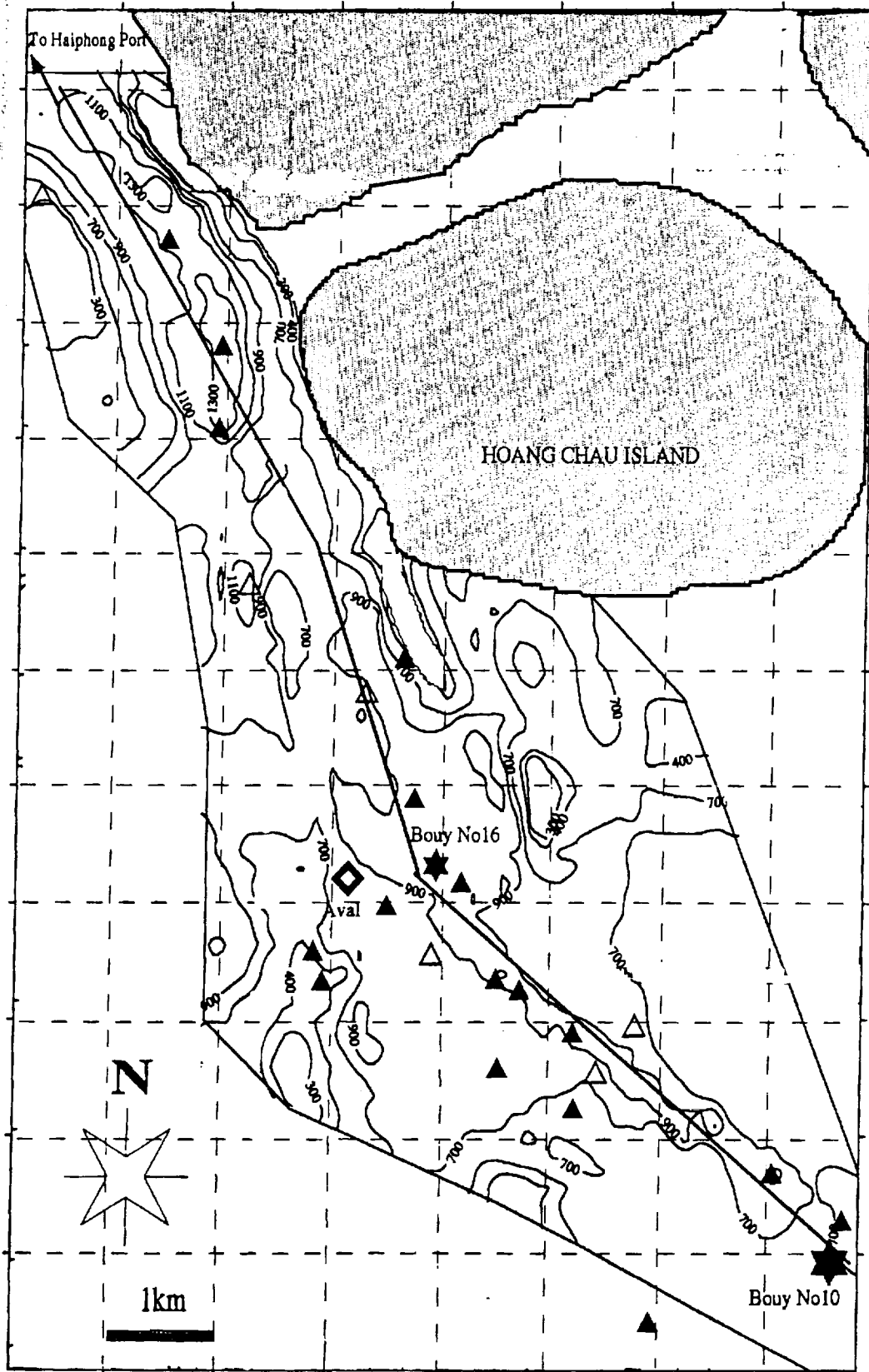


Fig. 1. Gamma background distribution (counts per ten seconds) in the vicinity of the access channel to Haiphong port. The positions of sediment cores recovered are marked by triangles.

clay particles at the level of 2-4 Bq kg<sup>-1</sup>. Its contribution into the gamma background is about one order of magnitude lower than that from the above naturally occurring isotopes.

Thus by tracking the gamma background semiquantitative information on the grain size composition of bed sediment can be obtained. Some practical uses of the method are shown and discussed in the paper.

#### REFERENCES

- [1] Taylor S. R. and McLennan S. M., *The Continental Crust: its Composition and Evolution*, Geoscience Texts, Blackwell Scientific Publications.
- [2] Hai P. S., Quang N. H. Hien P. D. Chuong P. N. and Xuan N. M., *Applications of Tracer Techniques to Studies of Sediment Transport in Vietnam*, Proc. 2<sup>nd</sup> Int. Conf. on Isotopes, Sydney, 11-16 October, 1997.