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DETECTION OF THIN TEPHRA DEPOSITS IN PEAT AND ORGANIC LAKE SEDIMENTS BY RAPID X-RADIOGRAPHY AND X-RAY FLUORESCENCE TECHNIQUES

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ABSTRACT

This paper reports the application of the X-ray image process of X-radiography to unopened, small diameter organic sediment cores containing thin tephra deposits. Second, a rapid technique for detecting tephra layers in peat samples by X-ray fluorescence (XRF) analysis is described.

X-RADIOGRAPHY

X-radiography has been widely used in sedimentary petrology as an effective technique in the study of textural, structural, fabric and compositional differences in sediment cores and rocks (e.g., Baker & Friedman, 1969; Hamblin, 1971; Scott & Lewis, 1979; Stow, 1979). The method records on photographic film differences in absorption of radiation by various constituents when X-rays are transmitted through a sample, and has been recently applied to piston cores taken from shallow, peaty lakes in the Waikato region (Green, 1979; Lowe, et al., 1980). Unopened cores encased in 60mm internal diameter PVC tubing were X-rayed in 50cm sections with a medical X-ray unit operated at 35 kV and 300 mA. Exposure time was 0.6 s with a focus-film distance of 90cm.

The X-radiographs reveal thin (<10mm), distinct and discrete, often finely-laminated tephra layers set in an essentially homogeneous matrix of very fine grained organic (humic copropel) lake sediments (Fig. 1). In positive prints, the tephras show as dark layers in contrast to a pale greyish-white background representative of the organic deposits. Resolution is such that wavy, very fine (<0.5mm thick) silt laminae intercalated with organic material are clearly seen. Some of these thinly bedded layers are not apparent from visual inspection of the freshly opened, split core. Further, only part of each of the thicker or coarser tephras is visible in the opened core. Both the lower and, particularly, upper portions of the deposit tend to be partly disseminated in the dark brownish-black organic sediments. Upon dehydration, the organic material cracks and shrinks away from the tephra layers which consequently become more clearly visible (Fig. 1b, c).

The X-radiographs thus provide rapid and accurate determination of tephra occurrence, stratigraphic position, and thickness. Similarly, the sedimentation rates of the organic material can be readily measured, and the fresh, unaltered organic deposits subsequently sampled accurately with respect to the tephra layers. The X-radiograph method is also advantageous in that it requires minimal sample preparation, it is non-destructive, and it provides a detailed visual record.

Future work will include assessment of a new X-ray image process, Xeroradiography (McMullin & van de Poll, 1979), which utilises a re-usable photo receptor plate instead of conventional X-ray film, and is claimed to improve further upon standard X-radiograph image definition, resolution and contrast.

XRF ANALYSIS

A rapid XRF technique has been devised and applied to studies on thin tephra deposits dispersed among organic material in peat cores from the Hauraki peat bog (Hogg, 1979; Hogg & McCraw, 1983). An air-dried core was sliced into 4cm-long sections which were crushed and then analysed by an energy dispersive ORTEC XRF unit for Fe and Si. The elemental count rates are shown in Fig. 2.

The peaks define the presence of inorganic material set in a background of organic deposits. The high Fe count rate for the Tuhua Tephra, as a solitary peak at 6m depth, is indicative of its peralkaline composition (Hogg & McCraw, 1983). In contrast, the high Si count rates at 1.5m and 2.3m depth, with negligible Fe peaks, correspond to deposits of calc-alkaline ?Kaharoa Ash and Taupo Pumice respectively. The high Si counts occurring at depths greater than 6m indicate thin layers of very fine and well sorted pure volcanic glass, and represent either overbank silt deposits from nearby rivers or very thin distal airfall tephras.

The XRF method described is thus valuable for detecting thinly bedded tephric deposits disseminated in peaty or organic material, and, in this instance, for also distinguishing between the calc-alkaline and peralkaline deposits.

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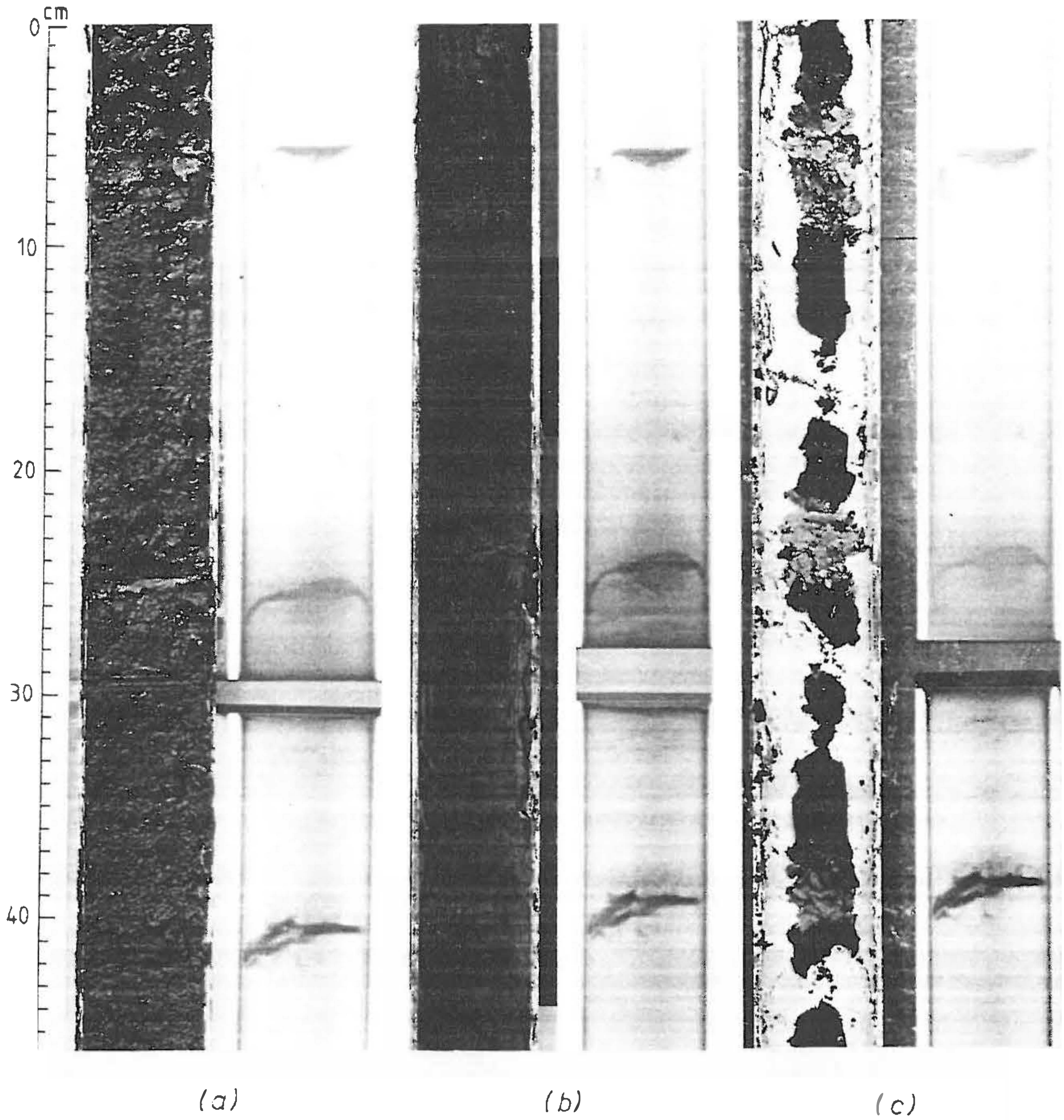

FIG. 1 - Photographs of opened small diameter (60 mm I.D.) organic sediment core (left) and matching X-radiograph (right) - (a) core freshly opened; (b) core dried 48 hours; (c) core dried two weeks. The X-radiographs reveal five possible tephra layers, three distinct (at 6, 25 and 40 cm depth) and two indistinct (at 32 and 36 cm depth). These become more evident in the core itself as the organic material dehydrates and contracts away from the tephras.

The core is from Lake Mangahia, located ~10 km SW of Hamilton City. The top tephra layer is Taupo Pumice.

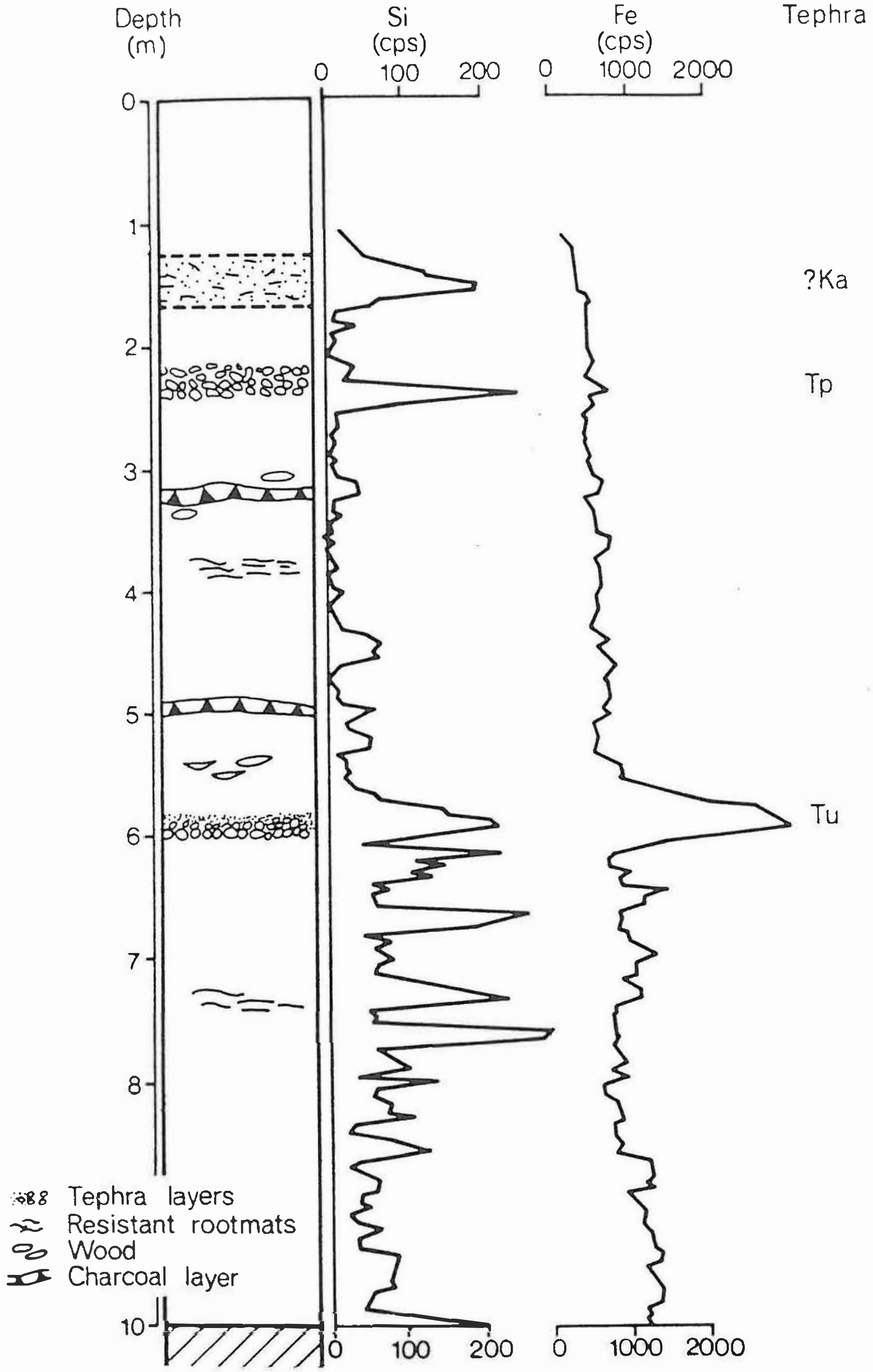

FIG. 2 - Schematic representation of a peat core from the Hauraki Peat Bog showing positions of ?Kaharoa Ash (Ka), Taupo Pumice (Tp) and Tuhua Tephra (Tu), and elemental count rates for Si and Fe from XRF analysis (*after* Hogg and McCraw, 1983).

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