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Short note

Uranium Content and Distribution in Whole-coal Samples, Sydney Coalfield (Upper Carboniferous), Nova Scotia, Canada

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ABSTRACT

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Uranium-poor bituminous coal-channel samples (mean and standard deviation 0.51 ± 0.99 ppm) from the Sydney Coalfield in Nova Scotia show top and bottom enrichment trends as are known from German, British and American coals of Upper Carboniferous age (Breger and Schopf, 1955; Francis, 1961; Gluskoter et al., 1977). The trends appear to be related to sedimentary processes rather than to secondary geochemical enrichment effects on the coal.

Sydney Coalfield (Fig. 1), the largest of the coal basins in Eastern Canada (Hacquebard, 1979, 1983), was investigated for uranium (U) concentration levels and their stratigraphical variability, after an initial survey by Zodrow and Zentilli (1979) revealed comparatively low U abundance. The present investigation, a follow-up of the survey, involves investigating 18 documented whole-seam channel samples from 10 successive coal seams (Table 1) for uranium. Each channel sample was subdivided in 15-cm lengths, yielding a total of 137 stratigraphical samples. The minimum weight of sample of coal was 150 g and the maximum 1,200 g, after drying; amounts of 5–8 g were split from each sample for U analysis. The use of such a large sample weight in combination with a 60-second counting time in delayed neutron activation analysis resulted in obtaining a detection limit of 0.01 ppm U. This result, in conjunction with the high accuracy that can be expected from the analytical method used, provided data suitable for the purpose of this investigation.

Results of the investigation are reported in Table 1. They show that for the seven high-ash samples, representing the 25-cm and the 36-cm 'thin seams',

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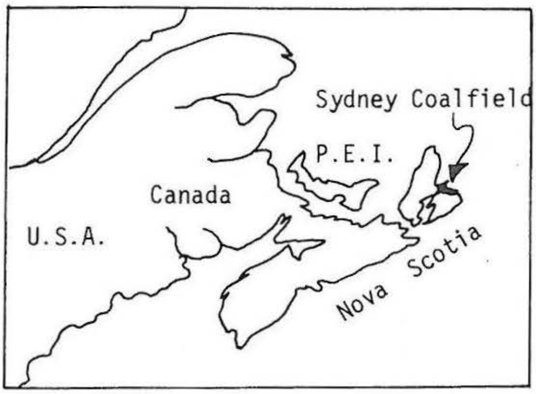

Fig. 1. Location map of Sydney Coalfield, Nova Scotia.

the mean value of 3.34 ± 2.46 ppm U is 10 times as large as that for the remaining lower-ash samples. The mean-level differences are probably facies-dependent (Kaplan et al., 1985).

The U ppm range in the remaining 130 samples is from 0.03 to 3.75 (Fig. 2) with mean of 0.36 ± 0.53 ppm U (their ashes would show 4 ppm U on average which compares with the 'thin seam' value). The majority of the data (61%) lie at or below the 0.24 ppm U mark and only 9% are above the 1 ppm level (Fig. 2), indicating a definite trend. The basis for the trend (Zodrow, 1986) is shown in Fig. 3 which portrays stratigraphical variation and comparative increases of U concentration near the top and the bottom that are characteristic for the channel samples studied. The sample frequencies (Fig. 2) may be represented by Pearson's Type I probability distribution model (Elderton and Johnson, 1969) rather than by the log-normal model, the latter showing a comparatively worse fit by chi-square statistics. The use of the usual statistics based on normal distribution is therefore not appropriate. However, a larger sample is required to decide which model could represent the data.

It is concluded that Sydney's coals are comparatively uranium-poor (Swanson et al., 1976; Gluskoter et al., 1977) and that the recorded elevated U levels at the top and the bottom are too low to suggest that secondary geochemical enrichment processes (cf. Vine, 1956) affected the coals (Krejci-Graf, 1983, p. 566; Patterson, 1955). An observed correlation coefficient of 0.78 between coal ash and U concentration as well as a multiple correlation of 0.70 between the latter variable and clay-indicating ratios Na/Al, Al/K, and Mg/Ca (Zodrow, 1985) would suggest the availability of clay influxes as a controlling factor for U concentration (Zodrow, 1983). This would account for the trends as presumably increasing amounts of clay are incorporated in the top and the bottom portions (terminating and initial peat stages, respectively) of a coal swamp that developed in a flood-plain environment (Hacquebard et al., 1965; Hacquebard and Donaldson, 1969). That other factors are involved in the control, besides that of clay abundance, is strongly suggested by the comparative neg-

TABLE 1

Sampling details and mean variation of uranium in channel samples

Coal seam	Seam thickness[1] (cm)	No. of channel samples	No. of samples	ppm U mean ± STD	ash % mean ± STD	Age
Pt. Aconi	105	3	19	0.40 ± 0.59	10.8 ± 8.9	
Overrider[2] Lloyd Cove	25	2	4	2.05 (1.34,2.36, 1.27,3.24)[#]	32.1 (23.7,39.0, 20.6,44.9)[#]	Early Cantabrian
Lloyd Cove	110	2	13	0.29 ± 0.46	6.0 ± 2.9	
Stubbart	215	2	29	0.44 ± 0.42	11.0 ± 7.1	
Overrider[2] Harbour	36	1	1	2.73	22.0	
Harbour:						West-phalian D
margin[3]	135	2	16	0.12 ± 0.07	11.9 ± 10.8	
central[4]	225	2	28	0.70 ± 1.07	3.4 ± 2.2	
Backpit	110	1	7	0.30 ± 0.31	10.6 ± 7.3	
Phalen	200	1	13	0.29 ± 0.18	6.3 ± 2.8	
Shoemaker[2]	25	1	2	6.23 (3.97,8.48)[#]	32.4 (26.6,38.2)[#]	
McAulay	45	1	3	0.28 (0.52,0.18, 0.15)[#]	13.8 (15.0,10.2, 16.3)[#]	West-phalian C
	Totals	18	137			
remaining samples		14	130	0.36 ± 0.53	8.6 ± 7.2	
'thin seam' samples		4	7	3.34 ± 2.46	30.7 ± 9.8	
total sample size		18	137	0.51 ± 0.99	9.7 ± 8.9	

[1]At point of sampling.
[2]Named 'thin seams'.
[3]At the western margin of the coalfield and Sydney Basin.
[4]In the central area of the coalfield.
[#]Individual data points.

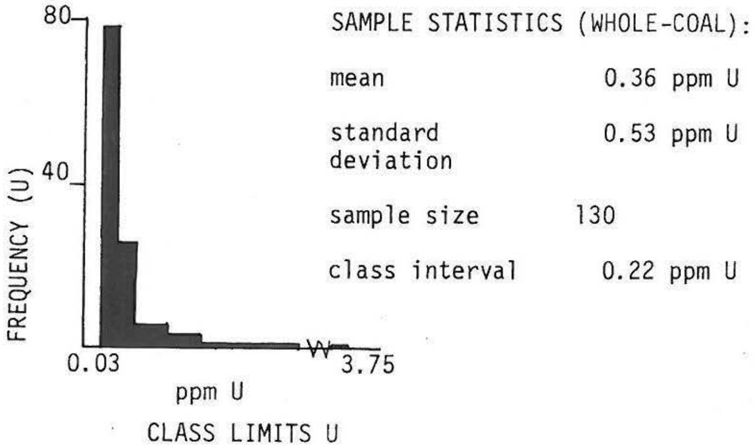

Fig. 2. Frequencies for uranium concentrations. Criteria that would fit Pearson's Type I model are $k = -6.32$; kurtosis $= 19.41$ and skeweness $= 13.25$ (cf. Elderton and Johnson, 1969).

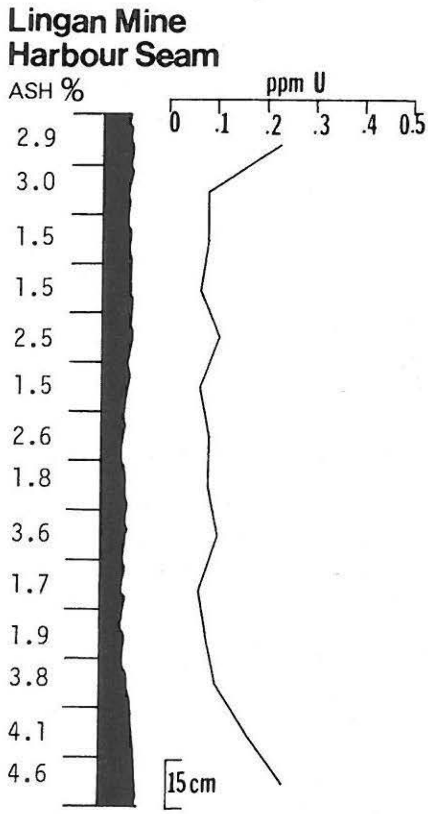

Fig. 3. Variation of U levels across a thick channel sample, noting co-variation between the metal and the coal ash percent listed.

ative association between ash and U in the 'central sample' of the Harbour Seam (Table 1).

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