THE ^{14}C CONTENT OF MODERN VEGETATION SAMPLES FROM THE FLANKS OF THE KATLA VOLCANO, SOUTHERN ICELAND

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ABSTRACT. Samples of living terrestrial plants comprising a moss (*Calliergon* sp.), *Carex* spp. and *Alchemilla* spp. were collected from the surface of the mire at Engimýri in Mýrdalur, southern Iceland, 10 km from the crater rim of the central complex of the Katla volcano. This area is 16 km from the fissures active in AD 1918 and was directly affected by the tephra fall. Although there is no hot-spring or fumerole activity in the area, sufficient volcanic activity during the weeks preceding sample collection produced a strong sulphurous odor in the streams. As part of a large-scale dating program, we analyzed the modern vegetation to determine whether anomalies caused by the uptake of "old" volcanic CO_2 were apparent. The results showed ^{14}C values for the *Calliergon* sp., *Carex* spp. and *Alchemilla* spp. of 113.2 ± 0.6 pMC, 113.03 ± 0.52 pMC and 113.10 ± 0.6 pMC, respectively. The $\delta^{13}C_{PDB}$ values were −28.7‰, −28.0‰ and −27.0‰, respectively. Similar vegetation, *i.e.*, terrestrial plants from a marsh environment in southern Scotland, were also analyzed as a comparison and gave ^{14}C values of 113.16 ± 0.55 and 112.98 ± 0.59 pMC. The implication is that Icelandic vegetation at Engimýri is not affected by "old" carbon from volcanic emissions and dates obtained for this Icelandic peat are acceptable and directly comparable with Scottish peat.

INTRODUCTION

We studied modern vegetation at a variety of sites which are, to some degree, volcanically active. We obtained a range of anomalous results with no consensus of opinion as to the extent of uptake of "old" ^{14}C by both aquatic and terrestrial plants. Sveinbjörnsdóttir *et al.* (1992) analyzed the ^{14}C content of modern aquatic moss (*Fontinalis antipyrecta* Hedw.) and various terrestrial plants from a geothermal area in southern Iceland, *ca.* 150 km northwest of Engimýri. They found that terrestrial plants had ^{14}C values between 113.8 ± 0.9 and 116.1 ± 0.8 pMC, whereas the aquatic moss living in geothermal water gave anomalously low values between 35.5 ± 0.8 and 45.5 ± 0.5 pMC. Bruns *et al.* (1980) found that modern terrestrial vegetation in the Thera region, which was last volcanically active in 1950, gave apparent ages of 1030 and 1390 BP. Modern vegetation from the Eiffel area (last active volcanism: 10,000 BP) gave anomalous results with apparent ages between 90 and 1360 BP. Saupé *et al.* (1980) also showed that anomalous ^{14}C concentrations in terrestrial plants can be induced by their proximity to "old" volcanic CO_2 emissions. Olsson (1983) noted that ^{14}C dates of the Landnám period in Iceland are often older than implied by the historical record. It is possible that this is due to the atmosphere over Iceland being deficient in $^{14}CO_2$. We discuss here our study on modern vegetation from both Iceland and Scotland to test whether volcanic activity significantly affects the ^{14}C activity of Icelandic vegetation. Peat samples from the same area in Iceland were also analyzed to test whether any effects are plant specific, *i.e.*, whether aquatic plants are affected more than terrestrial plants.

Engimýri is a peat bog situated 10 km from the crater rim of the Katla volcano in southern Iceland (Fig. 1). The volcano has been active for the entire period of peat growth; most of the mire consists of numerous tephra layers. The most recent tephra fall was in AD 1918. Present-day vegetation is predominantly moss (*Calliergon* sp., *Polytrichum* spp. and *Sphagnum* sp.) with *Carex* spp.,

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Alchemilla spp., *Armeria* sp. and *Equisetum* spp. dominating other species. No fully submerged aquatic plants were found.

The Scottish control site is a marshy area in the Pentland Hills (Grid Ref NT 195 597) (see Fig 1). The site is *ca*. 300 m from the nearest road and is used as pasture for sheep.

Methods

We collected samples in Iceland during July and August 1993. The green growth of that year was trimmed from the moss and the older growth discarded. *Carex* spp. and *Alchemilla* spp. were also

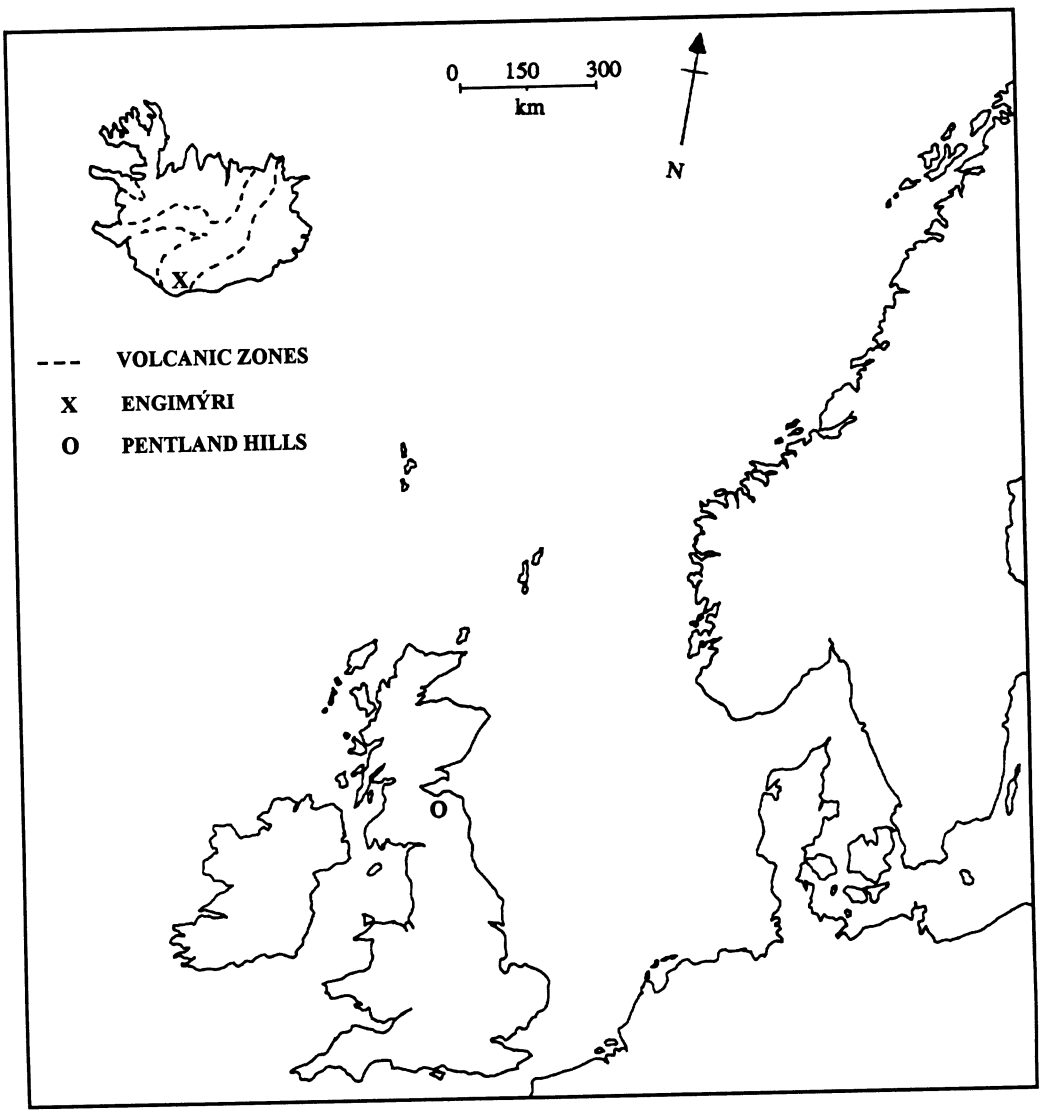

Fig. 1. Location of Icelandic and Scottish sites

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cleaned by hand-picking to remove any roots or other extraneous material. The Scottish samples were collected in June 1994 and were pretreated similarly. The samples were then acid-washed with hot 1M HCl for 3 h prior to thorough rinsing in distilled H_2O, and oven-dried at <50°C. The peat samples from Iceland were split into humic acid and humin fractions by alkali and acid washes followed by thorough rinsing with distilled water. Samples were converted to benzene and analyzed at the Scottish Universities Research and Reactor Centre Radiocarbon Laboratory.

Results

The results of the ^{14}C analyses of modern vegetation are given in Table 1.

TABLE 1. ^{14}C Results of Modern Vegetation in Iceland and Scotland

Lab no.	Vegetation type	^{14}C (pMC)	$\delta^{13}C$ ($‰_{PDB}$)
Iceland			
GU-7121	Moss (*Calliergon sarmentosum*)	113.20 ± 0.60	−28.7
GU-7100	*Carex* spp.	113.03 ± 0.52	−28.0
GU-7120	*Alchemilla* spp.	113.10 ± 0.60	−27.0
Scotland			
GU-7196	Moss (*Polytrichum commune*)	113.16 ± 0.55	−26.8
GU-7198	*Eriophorum* sp.	112.98 ± 0.59	−27.2

Peat horizons at Engimýri are easily defined by the tephra layers. Some of the peat contains the remains of the aquatic plant *Menyanthes trifoliata*. No modern samples of *Menyanthes* sp. were analyzed as this plant is now rare at the site. Areas of peat containing *Menyanthes* sp. were sampled from the same horizon and within 1 m of the peat that contained no trace of *Menyanthes* sp. If aquatic plants were affected by volcanic emissions, the samples containing the *Menyanthes* sp. might be expected to yield an older ^{14}C age and lower $\delta^{13}C$ values than samples that do not contain *Menyanthes* sp. The results of the ^{14}C analyses of the peat are given in Table 2.

Weighted means were calculated (Stuiver and Reimer 1993) for the aquatic samples and for the terrestrial samples. The results are given in Table 3.

There is no apparent difference between the ages obtained on samples with mixed remains and those with terrestrial remains.

Discussion

Peat that formed in pools showed no difference in ^{14}C content from peat formed above water. The only aquatic plant remains identifiable in the peat were *Menyanthes trifoliata*, a perennial herb that grows in shallow water on the surface of bogs and fens. The aquatic moss *Fontinalis antipyrecta* Hedw. can survive total submergence. Thus, *Menyanthes* sp. could photosynthesize atmospheric CO_2, whereas *Fontinalis* sp. could be more dependent on dissolved gases. This could explain why no age differences are apparent among *Menyanthes* sp., *Carex* spp. and *Alchemilla* spp. As the ^{14}C level of Icelandic and Scottish terrestrial plants gave very similar values, it may be that, for the Engimýri bog, atmospheric $^{14}CO_2$ concentrations do not decline as a result of geothermal activity.

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TABLE 2. The ^{14}C Results on Icelandic Peat

Lab no.	Sample	Mixed?	Fraction	Age	$\delta^{13}C$ (‰$_{PDB}$)
GU-7021	B1 E		Humin	2840 ± 60	–29.6
GU-7124	B2 B	yes	Humic acid	2850 ± 50	–28.5
GU-7125	B2 B	yes	Humin	2930 ± 70	–28.0
GU-7135	B3 5		Humic acid	2930 ± 50	–28.7
GU-7107	EG1 9	yes	Humic acid	3050 ± 40	–29.5
GU-7111	EG1 11	yes	Humin	3000 ± 40	–28.1
GU-7108	EG1 11	yes	Humic acid	2930 ± 40	–28.8
GU-7109	EG1 8	yes	Humin	2930 ± 50	–27.6
GU-7106	EG1 8	yes	Humic acid	2990 ± 40	–28.8
GU-7112	EG1 1		Humic acid	3060 ± 40	–28.4
GU-7110	EG1 10		Humin	2975 ± 40	–28.5
GU-7119	EG1 10		Humic acid	2970 ± 50	–29.1
GU-7117	EG1 2		Humin	3065 ± 50	–28.1
GU-7118	EG1 2		Humic acid	3000 ± 50	–27.3
GU-7115	EG1 3		Humin	2910 ± 50	–27.9
GU-7116	EG1 3		Humic acid	3020 ± 50	–28.7

TABLE 3. Weighted Mean Ages of Aquatic and Terrestrial Plants

Sample	Fraction	Weighted Mean Age (BP)
Aquatic	Humic acid	2965 ± 21
Aquatic	Humin	2966 ± 29
Terrestrial	Humic acid	3002 ± 21
Terrestrial	Humin	2958 ± 24
Aquatic	Total	2965 ± 17
Terrestrial	Total	2984 ± 16

CONCLUSION

^{14}C results on modern vegetation from Scotland and Iceland show similar values. This implies that volcanic gases in Iceland are sufficiently diluted in the atmosphere to render any uptake of "old" CO_2 by the vegetation negligible. We found no difference between the age of peat formed in pools and peat formed above water, implying that, in the Engimýri area, no "old" CO_2 is present in the pools or that the semi-aquatic plants still derive the bulk of their CO_2 from the atmosphere. We concluded from this study that in general the Icelandic vegetation is not affected by "old" carbon from volcanic emissions and that dates obtained for Icelandic peat are directly comparable with those obtained for peat from Scotland.

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References

Bruns, M., Ingeborg, L., Munnich, K. O., Hubberten, H. W. and Fillipakis, S. 1980 Regional sources of volcanic carbon dioxide and their influence on ^{14}C content of present-day plant material. *In* Stuiver, M. and Kra, R.S., eds., Proceedings of the 10th International ^{14}C Conference. *Radiocarbon* 22(2): 532–536.

Olsson, I. U. 1983 Radiocarbon dating in the Arctic region. *In* Stuiver, M. and Kra, R. S., eds., Proceedings of the 11th International ^{14}C Conference. *Radiocarbon* 25(2): 393–394.

Saupé, F., Strappa, O., Coppens, R., Guillet, B. and Jaegy, R. 1980 A possible source of error in ^{14}C dates: Volcanic emanations (examples from the Monte Amiata district, provinces of Grosseto and Sienna, Italy). *In* Stuiver, M. and Kra, R.S., eds., Proceedings of the 10th International ^{14}C Conference. *Radiocarbon* 22 (2): 525–531.

Stuiver, M. and Reimer, P. J. 1993 Extended ^{14}C database and revised CALIB 3.0 ^{14}C age calibration program. *In* Stuiver, M., Long, A. and Kra, R. S., eds., Calibration 1993. *Radiocarbon* 35(1): 215–230

Sveinbjörnsdóttir, A. E., Heinemeier, J., Rud, N. and Johnsen, S. J. 1992 Radiocarbon anomalies observed for plants growing in Icelandic geothermal waters. *In* Long, A. and Kra, R. S., Proceedings of the 14th International ^{14}C Conference. *Radiocarbon* 34(3): 696–703.