COMPARISON OF TWO AIR SAMPLING METHODS FOR DETERMINATION OF THE RADIOCARBON LEVEL IN THE ATMOSPHERE

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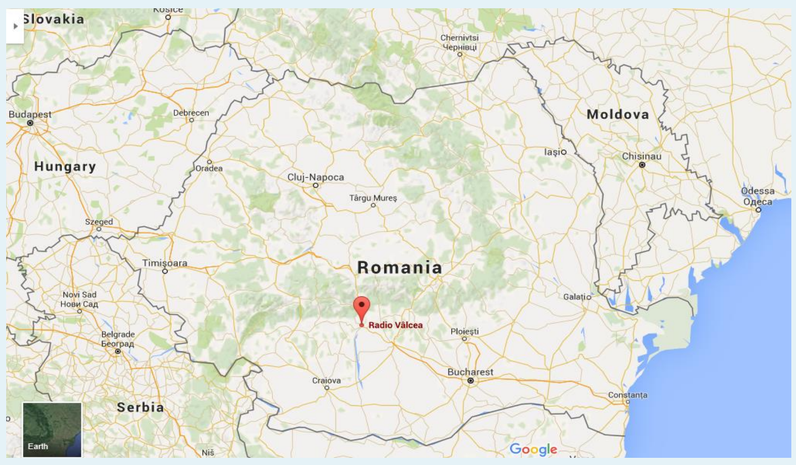
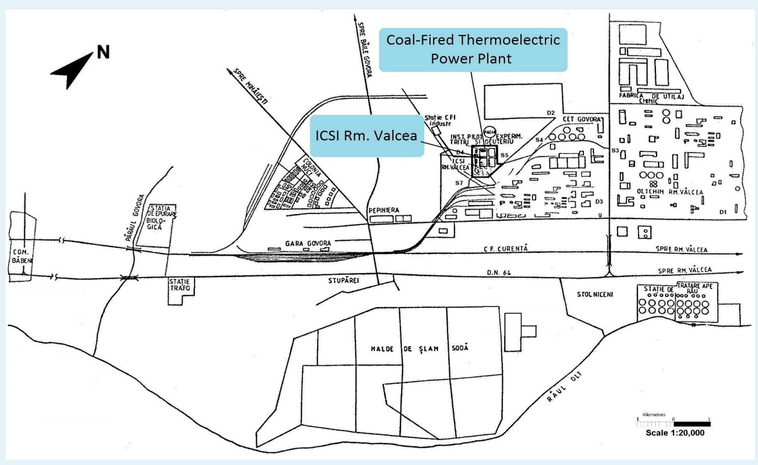
Abstract

The paper presents results of a comparison study of two air sampling methods for determination of the radiocarbon level in the atmosphere. The first sampling method involved static absorption of atmospheric CO_2 on the saturated carbonate-free NaOH solution. Second method involved active absorption of the atmospheric CO_2 by bubbling the air NaOH aqueous solution. This kind of comparison has not been done. Static absorption of atmospheric CO_2 is not a routine procedure in the environmental radioactivity monitoring laboratory, due to various unknown factors that appears during the CO_2 absorption process. The only advantage, but essential, is that of no request of different facilities as electric power, pump, or high-volume protective cage. It can be used from mountain's pasture to wild plain. The second method, widely used in radiocarbon laboratory, can quantify the performances evaluation of static absorption method of atmospheric CO_2. The measured ^{14}C specific activities have demonstrated the similarity of the two methods.

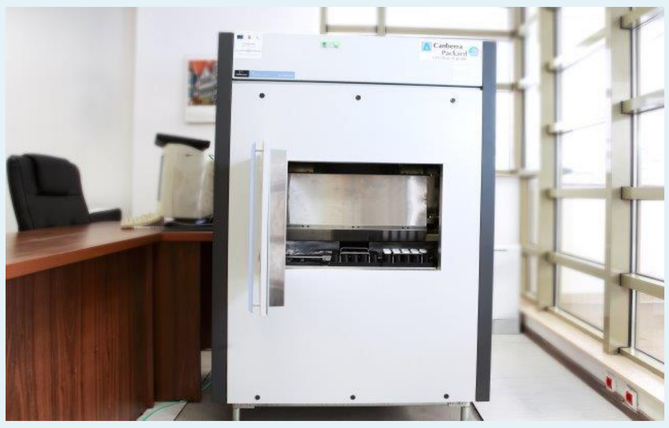


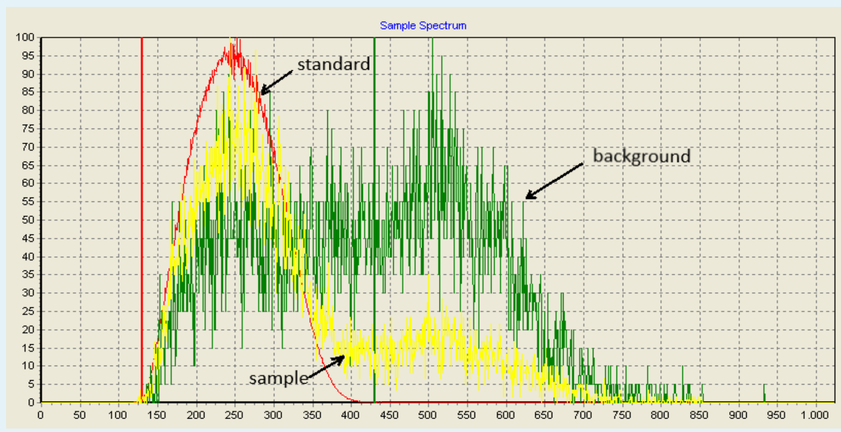


Location of experiments in Ramnicu Valcea city (Romania), 10 km south from the city centre in the Govora industrial area

CO_2 preparation line

CO_2 bubbling line





LS spectrometer Quantulus 1220 and a tupical C-14 spectrum for studied samples

LOCATION

The samples were collected in the vicinity of the Experimental Pilot Plant for Tritium and Deuterium Separation (PESTD) from the Institute of the Cryogenics and Isotopic Technologies (ICSI) placed about 10 km south from the Ramnicu Valcea city (Romania), in the Govora industrial area. In the Govora industrial area operates a 315 MW Coal-Fired Thermoelectric Power Plant and two chemical plants. This site is a particular one due to the Suess effect caused by continuously production of fossil CO_2.

STATIC CO_2 ABSORPTION

- Thin layer of solid NaOH (100 g) was put in a glass trays;
- The trays was placed outside on a covered terrace;
- For a one-month test, the trays were left out as follows: 4 x 1 week, 2 x 2 weeks and 1 x 4 weeks.

ACTIVE CO_2 ABSORPTION

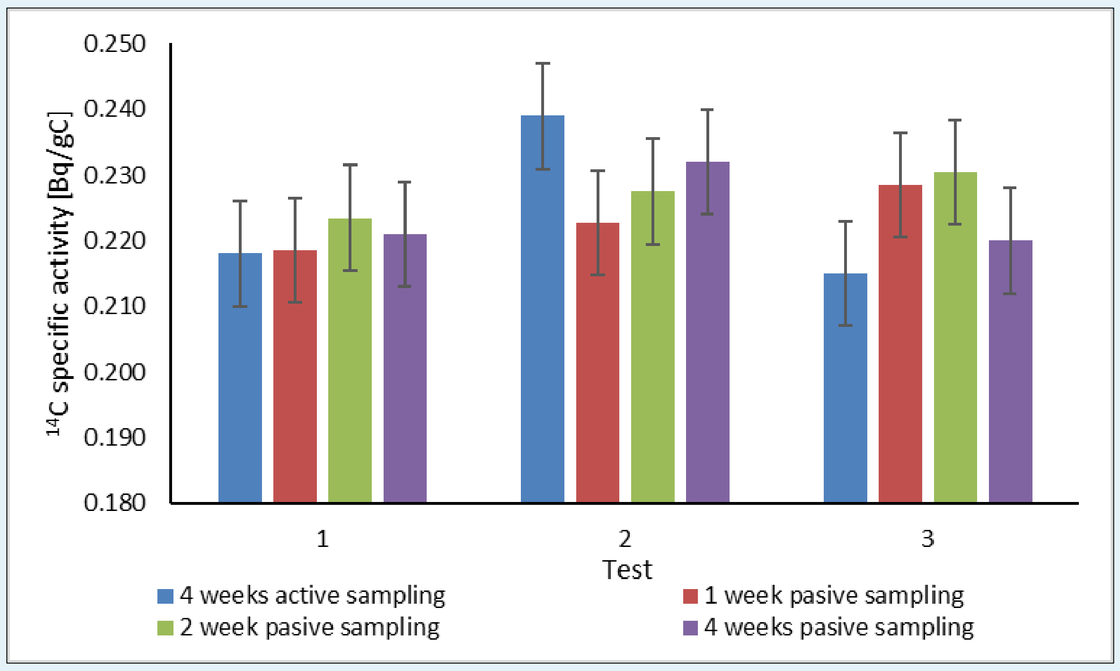
- CO_2 was collected by bubbling the air through two flasks filled with 500 mL of 3M NaOH solution;
- The flow rate was 10 L/h;
- Bubbling for 4 weeks;
- The same location was used as for static absorption.

SAMPLE PREPARATION AND MEASUREMENT

For both methods the samples were processed by acid carbonate decomposition, CO2 purification followed by direct absorption into liquid scintillation cocktail, and measurement by liquid scintillation method.

Test	^{14}C specific activity [Bq/gC]			
	Active absorption	Pasive absorption		
	4 weeks	1 week	2 weeks	4 weeks
1	0.218 ± 0.008	0.217 ± 0.008	0.224 ± 0.008	0.221 ± 0.008
		0.221 ± 0.008		
		0.214 ± 0.008	0.223 ± 0.008	
		0.222 ± 0.008		
Average		0.219 ± 0.008	0.224 ± 0.008	
2	0.239 ± 0.009	0.232 ± 0.008	0.228 ± 0.008	0.232 ± 0.008
		0.217 ± 0.008		
		0.222 ± 0.008	0.227 ± 0.008	
		0.220 ± 0.008		
Average		0.223 ± 0.008	0.228 ± 0.008	
3	0.215± 0.008	0.224 ± 0.008	0.229 ± 0.008	0.220 ± 0.008
		0.227 ± 0.008		
		0.231 ± 0.008	0.232 ± 0.008	
		0.232 ± 0.008		
Average		0.229 ± 0.008	0.231 ± 0.008	

^{14}C specific activity of the studied sample



^{14}C specific activity variation three months of observations

Conclusions

- The measured ^{14}C specific activities have demonstrated the similarity of the two methods. The differences are not significant taking into account the reported measured uncertainties. The reported uncertainties derive from the probabilistic nature of radioactive decay of sample and background.
- For 1 week sampling the ^{14}C specific activities were also similar with a minimum of 0.217 Bq/gC and a maximum of 0.232 Bq/gC. For two weeks sampling the ^{14}C specific activities were also similar. In second the ^{14}C specific activities were slightly higher due to the Suess effect caused by continuously but inconsistent production of fossil CO_2 produced by 315 MW Coal-Fired Thermoelectric Power Plant. During the tests, the CO_2 concentration varied between 300 and 1000 ppm.
- The active absorption method is widespread in laboratories. CO_2 capture from the atmosphere is done either by bubbling or using the Raschig tube. The major advantage of this method is that it can integrate large changes in terms of ^{14}C specific activity during the sampling period.
- For static absorption the only advantage, but essential, is that of no request of different facilities as electric power, pump, or high-volume protective cage. It can be used from mountain's pasture to wild plain. Static absorption of atmospheric CO_2 has its own drawbacks due to various unknown factors that can appear, but can be an alternative for isolated sampling locations.

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