ANTHROPOGENIC EFFECT ON NATURAL PROCESSES AND ITS STUDY USING RADIOCARBON METHOD

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ABSTRACT. **On the basis of radiocarbon concentration measurement data in the Earth's atmosphere we have determined the value of Suess effect using three different methods. The obtained results within the admissible error are in good agreement with each other.**

From the end of the 19th century parallel with the development of the Industrial Revolution the decrease (illusory decrease) of atmospheric radiocarbon concentration is noted, which is the result of nonradioactive fossils combustion. The anthropogenic effect on the natural processes and the decrease of the atmospheric radiocarbon concentration were experimentally studied for the first time by Suess [1] and therefore this phenomenon is known as Suess effect.

For today there have been already existed numerous factors which allow to account in detail all these phenomena which make an action on Suess effect:

a) Radiocarbon concentration for 1850-1940 has been determined with great preciseness (0.2 –0.3)% in wood rings [2] which makes easy the study of radiocarbon fluctuations unlike other works [3] where only averaged values of radiocarbon concentration are considered.

b) As a result of many-years stratospheric observations [4] half empiric dependence between cosmic rays and the parameters of solar activity is obtained

$$I(t) = I_0 \exp\left[-A\eta^{0.8}\varphi^{-1.2} \right] \qquad (1)$$

where *I(t)* is the intensity of galactic cosmic rays for *t* time moment; I_0 denotes the intensity of unmodulated flux of cosmic rays; η is the number of the groups of the Sun's spots and φ is their heliographic latitude; A is the constant multiplier. Thus there appeared the possibility to study more thoroughly the dependence of radiocarbon concentration on time in the mentioned period. While investigating Suess effect with the help of experimental data of radiocarbon concentration for the first time it becomes possible to exclude from them such significant factor as solar activity.

The Suess effect makes possible to study more thoroughly the geochemical processes proceeding with the participation of radiocarbon which helps the geochronologists to date more accurately this or that sample using radiocarbon method, etc.

The study of Suess effect is of particular significance for climatology because the raise of anthropogenic carbon dioxide action on climate becomes more and more noticeable [5].

The present paper aims to determine the value of Suess effect using different known methods on the basis of experimental data obtained at the laboratory of nuclear researches of the Tbilisi State University.

1.Radiocarbon method. Historically using this very method there was found the dilution of atmospheric radiocarbon with industrial CO_2. The difficulty of this approach is that it is impossible to determine just with the measurements the ^{14}C concentration existed before the industrialization. Therefore the Suess effect is calculated as the difference between the measured series of the ^{14}C concentration and the level of radiocarbon concentration of 1850. Then the data are approximated by the least-square method.

2.Cosmophysical method. This method gives the possibility to determine the value of Suess effect more accurately using annual measurements of radiocarbon. As was mentioned above the dependence of cosmic rays intensity on the parameter of solar activity is given by half empiric formula (1).

If we consider that (1) equality took place in the past too we can exclude modulated influence of solar activity from experimental radiocarbon series and obtain 'pure' image of Suess effect. For this it

is necessary to calculate the velocity of ^{14}C formation in the Earth's atmosphere from formula

$$I\,(0.2 - 50\ gv) = 385\ Q^{\,2.45} \tag{2}$$

and variation ($\delta\ ^{14}$C) of its concentration, which is calculated using five reservoir model of ^{14}C "redistribution" [4]. If we subtract the calculated value from radiocarbon experimental series we get the value of Suess effect.

3. Industrial method. This method is based on the evaluation of the injected industrial carbon content. For this there are used statistical data on the production amount of various fuels determined by the United Nations Organization. In this model it is also necessary to take into consideration the effect of carbonic gas flux in other spheres (ocean, biosphere, etc.) on its concentration in the atmosphere [3].

We have determined the value of Suess effect by radiocarbon method based on the data from [2] (Fig.1 fine dashed line).

At the same time we have modificated radiocarbon method in order to exclude modulated action of solar activity: linear approximation of data from earlier period of Suess effect by the least-square method (Fig.1, firm dashed line). We assume that in the period of Suess effect action modulated solar effect was denoted by the same line and from the obtained result we subtract approximated line in the period of Suess effect (Fig.1, continuous line).
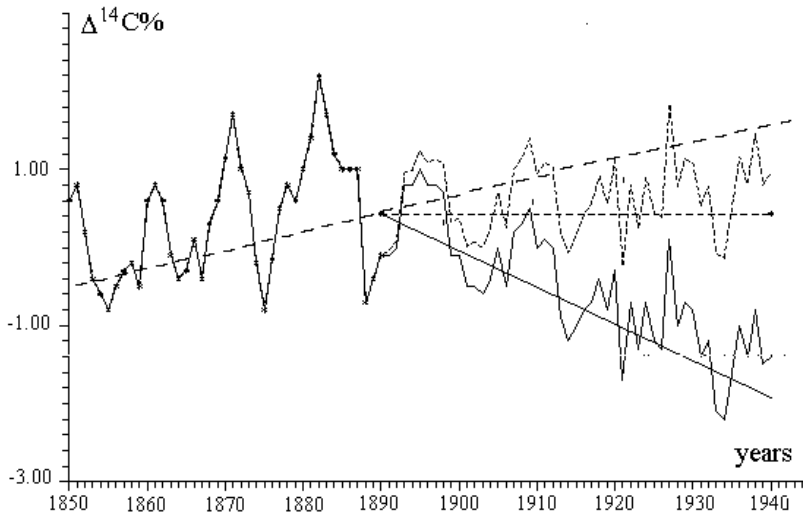
Fig.1.

The results were compared with the lines obtained by the above mentioned methods. It should be noted that according to our research the value of Suess effect made $\sim (2.4\pm0.35)$ % for 1940.
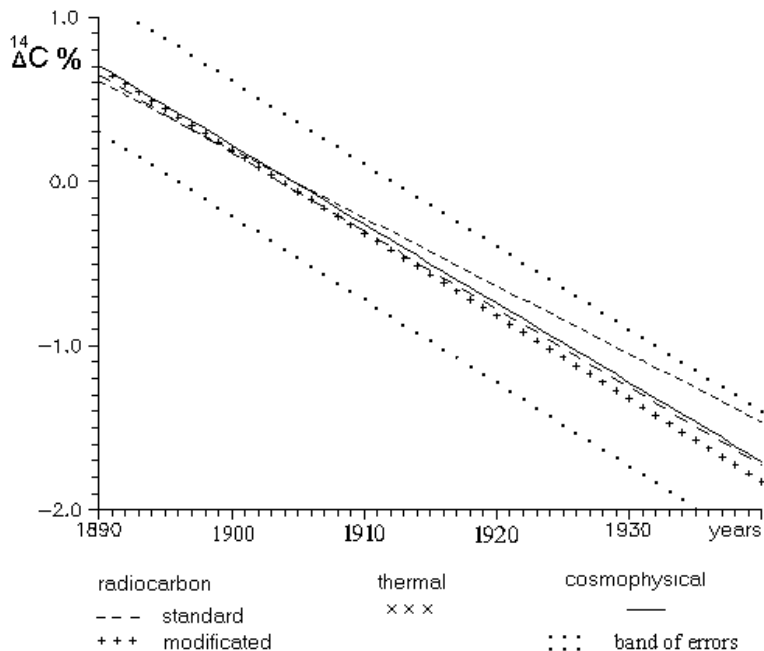
Fig.2.

As is seen (Fig.2) these methods within the experimental error evaluate the value of Suess effect. This proves the validity of three methods and the rightness of the calculations made by us.

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ანთროპოგენური ზემოქმედება ბუნებრივ პროცესებზე და მისი შესწავლა რადიონახშირბადული მეთოდით

დასკვნა

დედამიწის ატმოსფეროში გაზომილი რადიონახშირბადის კონცენტრაციის მონაცემების საფუძველზე განსაზღვრულია ზიუსის ეფექტის სიდიდე სამი სხვადასხვა მეთოდით. მიღებული შედეგები ცდომილების ფარგლებში კარგ თანხვედრაშია ერთმანეთთან.