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ANAIS - PROCEEDINGS

RADIOACTIVE CARBON-14 DATING OF GROUND WATERS IN "IPEN" FOR EVALUA
TION OF WATER RESOURCES IN RIO GRANDE DO NORTE AND PARANÁ BASIN.

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Abstract

^{14}C dating of deep ground waters from Potiguar basin and Paraná basin was carried out to identify zones of recharge. In all 28 samples, five from Potiguar basin and 23 from Paraná basin were analyzed for ^{14}C . The methods of sample collection and analysis adopted in our laboratory are described.

The analysis consists of transforming the carbon of the sample to benzene, through a synthesis process which involves four steps i.e. production of carbon di-oxide, production of lithium carbide, hydrolysis to acetylene and catalytic polymerization to benzene. The specific activity of the synthesized benzene is measured by liquid scintillation counting. Ages up to 43000 years can be dated using 2σ criteria and about 4g of carbon in the sample. The corrections for initial ^{14}C content have been made by using the model of Vogel. Ground water ages thus obtained have been interpreted from the point of view of identifying zones of recharge and present and future exploitation.

Introduction

Different corrective models have been proposed in literature for estimates of initial ^{14}C contents for dating ground waters. Based on very large number of ground water samples analyzed, the model of Vogel gives a good average estimate of 85% for the initial ^{14}C content. In the present study deep ground waters of Potiguar basin in Rio Grande do Norte and Paraná basin have been dated by ^{14}C analysis using the model of Vogel with the objective to identify the zones of recharge in these basins.

In the ^{14}C dating laboratory of Instituto de Pesquisas Energéticas e Nucleares-IPEN, the carbon of the fossil and ground water samples is first transformed to carbon di-oxide by thermal oxidation or acid destruction. The gas is converted to lithium carbide and then to acetylene by hydrolysis. Polymerization of the acetylene is then carried out using a catalyst to produce benzene. The specific activity of the radiocarbon is measured by liquid scintillation counting technique. The carbon of the water sample in the field is extracted by precipitation or absorption (sodium hydroxide) techniques. Ages of about 43.000 years can be dated using 2σ criteria and about 4g of carbon in the sample. Details of the facility are described in literature ⁽¹⁾.

The age of the ground water is given by

$$t = \frac{1}{\lambda} \ln \frac{A_0}{A}$$

where A = carbon - 14 specific activity (dpm/g) in the sample, A_0 = initial carbon - 14 specific activity (0.85 x specific activity 14.24 dpm/g of NBS - oxalic acid-Model of Vogel), $\lambda = 0.693/t_{1/2}$ ($t_{1/2} = 5370$ years).

When two interconnected wells are concerned, the time of transit of ground water, based on carbon-14 dating is obtained by

$$t_1 - t_2 = 8270 \ln A_2/A_1$$

where t_1 = age of water in well 1, t_2 = age of water in well 2.

A_1 and A_2 are the respective specific activity of carbon-14.

Potiguar basin

A study of water resources in the north-eastern region of Brazil was undertaken in collaboration with Instituto de Pesquisas Tecnológicas - IPT, São Paulo and Centro de Energia Nuclear na Agricultura - CENA, Piracicaba, São Paulo. In the work reported here some details of the work specifically carried out by IPEN i.e extraction of carbon di-oxide in the field, analysis of carbon -14 in the laboratory and interpretations of the ground water ages are reported.

ed. The complete work of the geohydrological study of the region forms part of other publication (2).

In the Potiguar basin, in all five wells were sampled. Samples varied from 120 to 240 litres in volume as determined from previous bicarbonate, carbonate analysis.

The carbon di-oxide was extracted by absorption on sodium hydroxide and the resultant sample analyzed in the laboratory. The results are shown in Table 1.

Table 1

No.	Date	Aquifer	Location	Age*(years)
1	Dec.80	?	Tabuleiro do Norte	13.611 ± 703
2	"	Artesian	Colônia Penal	16.761 ± 905
3	"	"	Tibau	17.035 ± 792
4	"	"	Salinas de Macau	15.257 ± 501
5	"	Unconfined	João Câmara	191 ± 186

* Based on $C_0 = 0.85 \times$ specific activity of NBS - oxalic acid (14.24dpm/g) - model of Vogel; average half life 8270 years.

The conclusion drawn from the study are: 1) the region around the first four samples has low recharge potential and the region around fifth sample is a zone of recharge; 2) the region around Tabuleiro do Norte, as contrary to the assumed hypothesis, is certainly not a recharge zone; 3) There is gradual increase of the age in the direction of samples 1, 2 and 3, indicating that the aquifer is flowing towards Tibau; 4) Regional flux from Colonia Penal to the direction of Tibau can be confirmed and in this region the stage speed of the deeper ground water is about 140m/y.

Potiguar basin in most of its part consists of sandstone recommending the use of the model of Vogel. The region of sample 5 consists of carbonate formation where the water is of recent origin. The water of this region is not very potable, The use of isotope exchange model in this region to give better estimate of age will not change the overall picture.

Paraná basin

In all 23 samples in the form of precipitates were collected by Departamento de Águas e Energia Elétrica - DAEE and analyzed in the laboratory of IPEN. Five ground water samples yielded recent ages which identify the zones recharge. Four samples yielded ages from 600 to 2400 yrs indicating zones of

mixing of deeper and shallow waters. Five samples yielded ages around 5000 yrs. Of the remaining nine samples, six yielded age around 10000 yrs, one 15000 yrs, one 19000 yrs, and one 30000 yrs (i.e. Presidente Prudente)-showing that as waters flow from Lima, S. José do Rio Preto, Fernandópolis to the direction of Presidente Prudente, they become more and more confined. The region around Avaré and Bauru (ages between 600 and 7000 yrs) is zone of greater influence of fresh waters of the surrounding rivers possibly through fissures in the geological formations.

In this basin there are only stray occurrences of carbonate formations and where they exist one could use isotope exchange model instead of Vogel's model for slightly better estimates of ages.

Present study has been useful to indicate recharge zones by recent ages, zones of intermixing of fresh and old waters and zones of really confined and old waters from the point of view of present and future exploitation of ground waters in Potiguar and Paraná basins. For most practical purposes even the uncorrected ages are of great value in providing information to ground water exploitation agencies.

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