*Acta Ciencia Indica, Vol. XLI P, No. 4, 197 (2015)*

# COMPARATIVE STUDY OF $C^{14}$ DATING OF GROUND WATER SAMPLES OF DIFFERENT REGIONS BY AMS

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RECEIVED : 31 December, 2015

Carbon$^{14}$ measurement on DIC (dissolved inorganic carbon) are used to provide information on the relative ages of the ground water pumped from various locations of different regions across the world. In this study a comparative study of $C^{14}$ dating of ground water samples of different regions have been made to draw some important inferences.

**KEY WORDS :** Accelerator Mass Spectrometry, $C^{14}$.

## INTRODUCTION

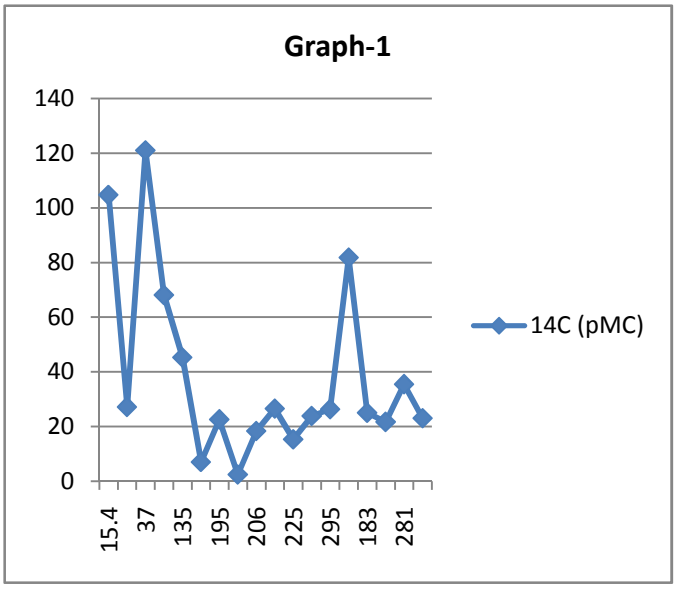
A$C^{14}$ is a naturally occurring radioisotope of carbon having a half life of approximately 5570 years. It is a radionuclide which is very useful in its extensive applications in dating of objects and as a tracer element. To determine the age of any archaeological evidence, surface, ground water or quartz samples of different rocks etc., it is needed to convert the age from A.D. to B. C. scale. For this, 1950 was used as a reference year and ninety five percent activity of NBS Oxalic acid was used as a modern standard. $C^{14}$ data are expressed as percent modern carbon ( pMC) by comparing $C^{14}$ activities to the specific activity of National Bureau of Standards Oxalic acid of 12.88 disintegrations per minute per gram of Carbon in the year 1950 equals 100% modern carbon (pMC). (Izbicki, *et. al*., 1998). $C^{14}$ activities are used to determine the age of ground water since recharge on timescales from a range of present to more than 45000 years B.P. $C^{14}$ is not the part of the water molecule, however in the dissolved constituents $C^{14}$ activities are observed through chemical reactions.

## COMPARATIVE STUDY OF $C^{14}$ OF GROUND WATER OF DIFFERENT REGIONS

By the isotopic methods of ground water dating it has been possible to estimate the mean ages of ground water pumped from wells. Hoque and Burgess (2012) estimated the ages of deep ground water (≥150mbgl) in South East Bangladesh. $^{14}C$ activity has the range from 2.53 to 18.8pMC with highest activity at 185mbgl depth at the eastern margin of the basin along the piedmont and lowest activity at 203mbgl found close to the coast.

**Table-1**

| Sample ID | Latitude | Longitude | Well intake depth (m) | $^{14}C$ (pMC) |
|---|---|---|---|---|
| DT11S[a] | 23.5970 | 90.7973 | 15.4 | 104.71±0.65 |
| DT11M[a] | 23.5970 | 90.7973 | 87.8 | 27.23±0.28 |
| CU07L[b] | 23.4191 | 91.1360 | 37.0 | 120.98±0.76 |
| KHOP4[a] | 23.3405 | 90.9226 | 25.0 | 68.15±0.5 |
| DS08D | 23.6059 | 91.0527 | 135 | 45.33±0.37 |
| JB10D | 23.6209 | 90.8604 | 150 | 7.07±0.14 |
| LC06D | 23.1740 | 91.0064 | 195 | 22.67±0.25 |
| CL02D | 22.7676 | 90.8599 | 203 | 2.53±0.09 |
| FG01D | 23.1263 | 90.7565 | 206 | 18.41±0.25 |
| NN09D | 23.8900 | 90.9692 | 222 | 26.61±0.26 |
| DB04D | 22.9837 | 91.3371 | 225 | 15.37±0.20 |
| BJ03D | 22.9934 | 91.0911 | 244 | 23.9±0.27 |
| DT11D | 23.5965 | 90.7962 | 295 | 26.41±0.26 |
| CG05D | 23.2293 | 91.3067 | 185 | 81.8±0.61 |
| KHOP5[a] | 23.3403 | 90.9226 | 183 | 25.06±0.26 |
| KH98D | 23.4360 | 90.8389 | 205 | 21.76±0.25 |
| KHOP1[a] | 23.3402 | 90.9227 | 281 | 35.53±0.31 |
| KHOP2[a] | 23.3404 | 90.9221 | 336 | 23.11±0.26 |

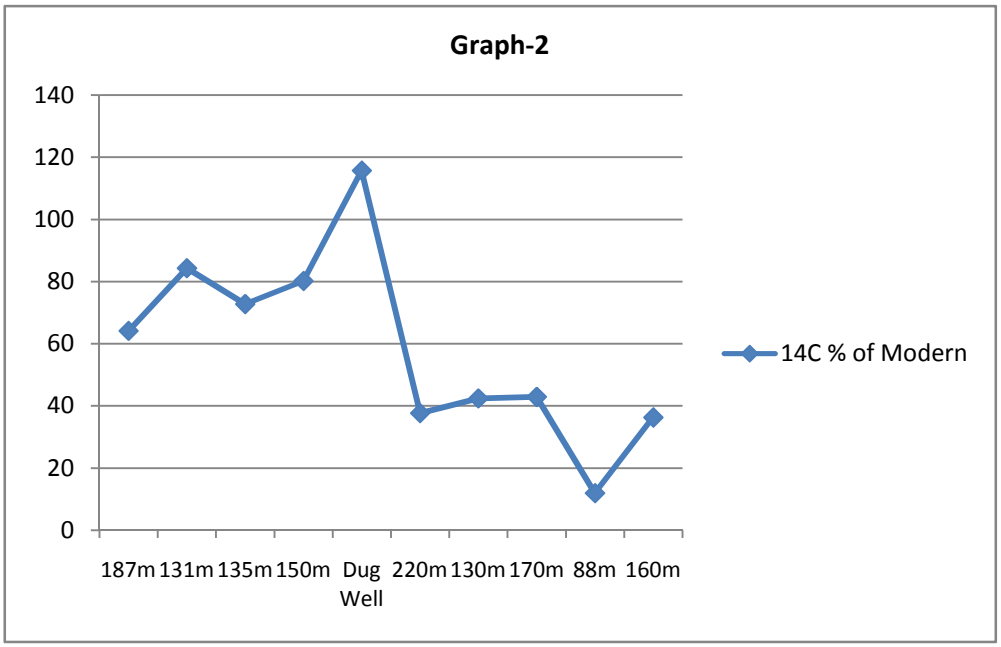



In Radio Carbon, Vol. 13, No. 2, 1971, P-442-449, D.P. Agrawal et.al. have deserved the samples collected by the members of their Geophysics Group who studied ground water resources of Gujarat, Rajasthan and Uttar Pradesh in India.

Gujarat series & Rajasthan series reports were submitted by V.N. Nizampurkar and U.P. series reports were submitted by P.S. Dandkhane. The report of ground water samples of Gujrat were as follows:

**Table-2**

| Lab. No. | Location | Depth | $^{14}C$ % of Modern |
|---|---|---|---|
| TF-841 | Kalol, Dist.-Mehsana | 187m | 64.15±0.98 |
| TF-842 | Mansa, Dist.-Mehsana | 131m | 84.31±0.90 |
| TF-843 | Pilvai, Dist.-Mehsana | 135m | 72.76±0.95 |
| TF-845 | Dama, Dist.-Banaskantha | 150m | 80.21±0.94 |
| TF-846 | Deesa, Dist.-Banaskantha | Dug Well | 115.73±1.25 |
| TF-1095 | Bhairwa, Dist.-Jaisalmer | 220m | 37.64±0.72 |
| TF-1096 | Bhairwa, Dist.-Jaisalmer | 130m | 42.39±0.79 |
| TF-1097 | Bhairwa, Dist.-Jaisalmer | 170m | 42.88±0.60 |
| TF-1121 | Ajasar, Dist.-Jaisalmer | 88m | 11.91±0.33 |
| TF-1120 | Ajasar, Dist.-Jaisalmer | 160m | 36.27±0.87 |

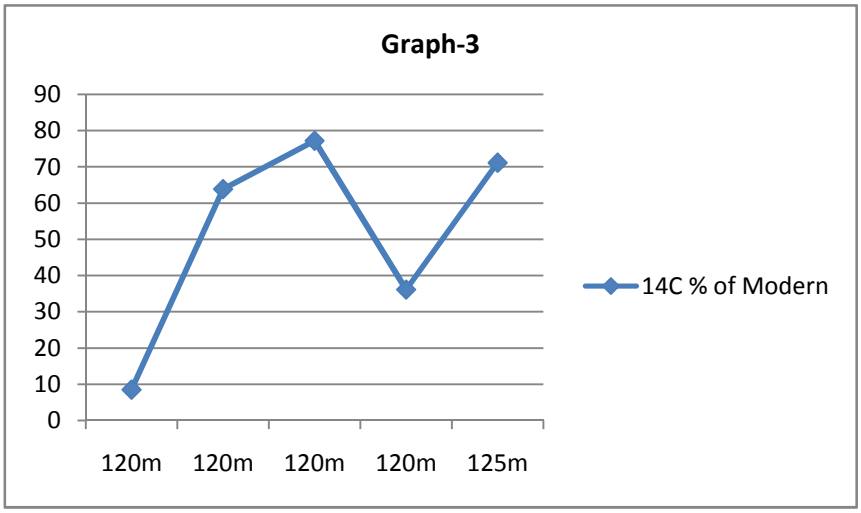



Similarly reports of Uttar Pradesh series are as follows:

**Table-3**

| Lab. No. | Location | Depth | $^{14}C$ % of Modern |
|---|---|---|---|
| TF-1038 | Kakragaor, Dist.-Meerut (29°N Lat. 77°12' E Log.) | 120m | 8.54±0.33 |
| TF-1039 | Shukartal, Dist.-Muzaffar Nagar (29°24' N Lat. 78°5' E Log.) | 120m | 63.86±1.04 |

| Lab. No. | Location | Depth | $^{14}C$ % of Modern |
|---|---|---|---|
| TF-1040 | Dashawali, Dist.-Aligarh (28°48' N Lat. 78°5' E Log.) | 120m | 77.19±0.90 |
| TF-1042 | Bhongaon, Dist.-Mainpuri (27°12' N Lat. 79°5' E Log.) | 120m | 36.14±0.58 |
| TF-1043 | Khanda, Dist.-Bulandshahar (28°24' N Lat. 77°54' E Log.) | 125m | 71.14±1.20 |




Combining $C^{14}$ age dates with isotopic characterization and interpretation of chemical composition provides important information on timing, rate and sources of recharge (Maduabuchi, *et. al*. 2006).

Similarly, Carbon-14 dating of ground water in the Palouse Basin of Coulumbia river basalts of Eastern Washington and Northern Idaho are derived have shown the accumulation of the oldest ground water in the topographically highest areas of the basin adjacent to the basin divide. Douglas, Alyssa A. Osiensky, James L. and Kellen, C. Kant *et. al*. (2005) have in his paper discussed about $C^{14}$ dating of ground water in Palouse Basin. From their finding here only datas of the samples collected in 2001 is given here for the comparative study (upper portion of the aquifer system) .

**Table-4**

| Well Name | Geographical Layer | Age (B.P.) | $^{14}C$ (pMC) |
|---|---|---|---|
| Cuentry | Granite | Modern | 104.5 |
| UIGRS | Alluvium | Modern | 115.8 |
| Loess 6A | Loess | 1600 | 82.6 |
| Stalnaker | Wanapum | 14600 | 17.1 |
| COM2 | Wanapum | 8700 | 35 |
| COM3 | Wanapum | 9100 | 33.3 |
| COP3[a] | Grande R. | 13000 | 20.8 |
| COP5 | Grande R. | 16300 | 14 |

| | | | |
|---|---|---|---|
| COP6 | Grande R. | 17100 | 12.6 |
| WS45 | Grande R. | 14300 | 17.7 |
| WS46 | Grande R. | 21100 | 7.8 |
| Palouse 1 | Grande R. | 21900 | 7.1 |
| Palouse 2 | Grande R. | 26400 | 4.1 |

# Conclusion

The distribution of $^{14}C$ in the ground water in found to be highly variable and reflects complex, vertical migration pathways between the land surface and producing zones at depth. All units seem to be heterogeneous. Varied results at varied heights, depth are due to potential variability of the sources, variation in soil developments and variations in topography.

As all the graphs of table 1, 2, 3 have been plotted between the depth along horizontal axis and the pMC along the vertical axis represented by Graph 1, Graph 2, Graph 3, it has been observed the general trend of decreasing $^{14}C$ (pMC) concentrations with depth of well penetration exists throughout the various regions.

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