

Dating groundwater in The Netherlands

ATE VISSER* AND HANS PETER BROERS

Deltares, Princetonlaan 6, 3584CB Utrecht, The Netherlands
(* correspondence: ate.visser@deltares.nl)

The national groundwater quality monitoring network of the Netherlands was installed between 1980 and 1992 [1]. Each of the 425 wells consists of two piezometers screened at 10 or 25 m below the surface. The screen depths were chosen with a conceptual model of the groundwater age distribution in an unconfined aquifer in mind. Directly after installation, groundwater samples were collected from the monitoring screens and analyzed for tritium content, and an exponential function was fitted for each well to obtain initial estimates of the travel time distribution and recharge rate [2, 3].

Since 2001, a total of 95 screens have been sampled for $^3\text{H}/^3\text{He}$; 34 of which have also been sampled for CFCs and SF6. The $^3\text{H}/^3\text{He}$ ages showed significant deviations from the previously assumed exponential travel time distribution [4]. Furthermore, about half of these samples showed the effects of noble gas depletion (degassing) by the escape of N_2 produced by denitrification. The accuracy of apparent $^3\text{H}/^3\text{He}$ ages of degassed groundwater samples was estimated to be 3 years based on a Monte-Carlo type sensitivity analysis. Numerical two-phase transport simulations showed that the $^3\text{H}/^3\text{He}$ ages of degassed groundwater had an uncertainty of 6 years, with a bias of 2 years; and confirmed the degradation of CFCs in nitrate-reducing environments [5].

The old tritium measurements proved to be very suitable to improve the $^3\text{H}/^3\text{He}$ age estimates by comparison with the historical concentrations of tritium in precipitation. Furthermore, this comparison shows that the sum of tritium and tritiogenic ^3He concentrations in groundwater recharged between 1960 and 1970 is systematically below the historical concentrations of tritium in precipitation in the Netherlands, while young groundwater compares favorably. The origin of this bias is uncertain. Binary mixing between young and old groundwater is unlikely from a hydrological perspective. The bias cannot be explained by dispersion model, but could be attributed to the diffusion of tritium-free water from clay lenses [6].

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β -carotene as a potential biomarker in Martian evaporites detected by Raman spectrometry

P. VÍTEK^{1*}, J. JEHLIČKA¹, H.G.M. EDWARDS²
AND K. OSTERROTHOVÁ¹

¹Institute of Geochemistry, Mineralogy and Mineral Resources, Charles University in Prague, Albertov 6, 128 43 Prague 2, Czech Republic
(*correspondence: vitek2@natur.cuni.cz)

²Division of Chemical and Forensic Sciences, University of Bradford, Bradford BD7 1DP, United Kingdom

Results of recent Martian exploration, have confirmed the presence of evaporitic minerals on Mars, which are proposed as potential habitats for microbial (halophilic) life on Mars [1-3]. In this work, Raman microspectrometry was tested as a nondestructive method of determining the lowest detectable β -carotene content in experimentally prepared evaporitic matrices – gypsum, halite and epsomite. Here, 514,5 nm excitation source was compared with 785 nm excitation studied in our previous work [4] and portable Raman instrumentation was also evaluated. Mixtures were measured directly and through the crystals of gypsum and epsomite.

As shown in the figure 1, we have obtained excellent β -carotene signal at the 10 mg kg⁻¹ level by 514,5 nm excitation source. Even at 0,1-1 mg kg⁻¹ (514,5 nm) and 1-10 mg kg⁻¹ (785 nm) the signal was recorded. Concentrations of β -carotene of about one order of magnitude higher were identified when analyzed through single crystals of gypsum and epsomite, respectively. Surprisingly low concentrations of β -carotene were identified non-destructively by Raman microspectrometry in the evaporitic mixtures.

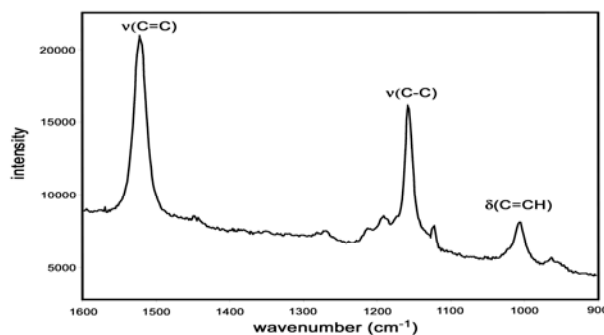


Figure 1: 10 mg kg⁻¹ of β -carotene in halite matrix (514,5nm).

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[2] Rothschild (1990) *Icarus* **88**, 246-260. [3] Mancinelli *et al.* (2004) *Adv. Space. Rev.* **33**, 1244-1246. [4] Vitek *et al.* (2009) *Planet. Space Sci.*, in press.