

## TC Project Achievements Report

**Project Number:**

**TUN/8/020**

**Project Title:**

**Assessing Phreatic Waters in Southern Tunisia Through the Application of Isotope Tracers**

**Project Objectives:**

To characterize groundwater reservoirs in South Tunisia to better understand the hydrogeology and define their vulnerability to different external factors

**Project Background (Optional):**

Underground waters in Southern Tunisia are subjected to accentuated pressure due to severe climate conditions and increasing man-induced constraints. Currently, these water resources are managed based on strategies which are poorly adapted to their vulnerability (irrational utilization and over-exploitation, and contamination by industrial and agricultural waste). This project could contribute to improving their management strategy through the introduction of isotopic techniques in addition to conventional hydro-geological techniques. The immediate beneficiary of this intervention is the main counterpart, the Laboratory for Radio-Analysis and Environment at the National School of Engineers in Sfax. Professionals within the institution will be trained and be directly involved in the project related sampling, management and analysis. Other beneficiaries include institutions within the Government, the Regional Commission for Agricultural Development (CRDA), the Société Nationale d'Exploitation et de Distribution des Eaux (SONEDE) and others that are tasked with the management of water resources within the country. The end users will mainly be consumers of the ground water resources in the area. With characteristics known and vulnerable areas identified, they will be provided better services by operators and professionals within the sector. The project started in 2009 with an estimated duration of 03 years and the counterparts are Centre National des Sciences et Technologies Nucléaires (CNSTN); Sidi Thabet, Université de Sfax; École nationale d'ingénieurs de Sfax; Département de Génie géologique; Laboratoire de Radio-Analyses et Environnement (LRAE); Sfax.

**Project Outputs (Required):**

[The 'deliverables' of a project, i.e. its immediate products or services delivered to target groups and constituents in Member States as a consequence of the project's activities.]

The IAEA awarded 02 fellowships totaled 02 man months and the fellows received training in (i) general installation and operation of the LGR Laser Isotope Instrument; complete installation of the machine, sample preparation, and run a series of samples, post-processing with Excel spreadsheet. Maintenance and troubleshooting; changing syringes and septa, cleaning water line etc. Preparation of in-house standards and their proper storage. Practical training on water sample treatment for tritium analysis and data evaluation. Preparation and measuring techniques for low level tritium and data quality assurance; (ii) Training on the Laser spectrometry for <sup>13</sup>C analysis. Training includes the following - Installation and the maintenance of <sup>13</sup>C Laser analyzer - Standard preparation and calibration - Performing analysis on water samples - Samples preparation - Results calculations and post processing data. In addition, the Agency supplied necessary equipment and consumables including: Weather station and parts, Sekuroka bêta Protection round Containers, Geiger Counter, Professional Water distillation system, Electrodeposition Equipment and parts, carbon-14 sampling chemicals, Sodium Peroxide etc.

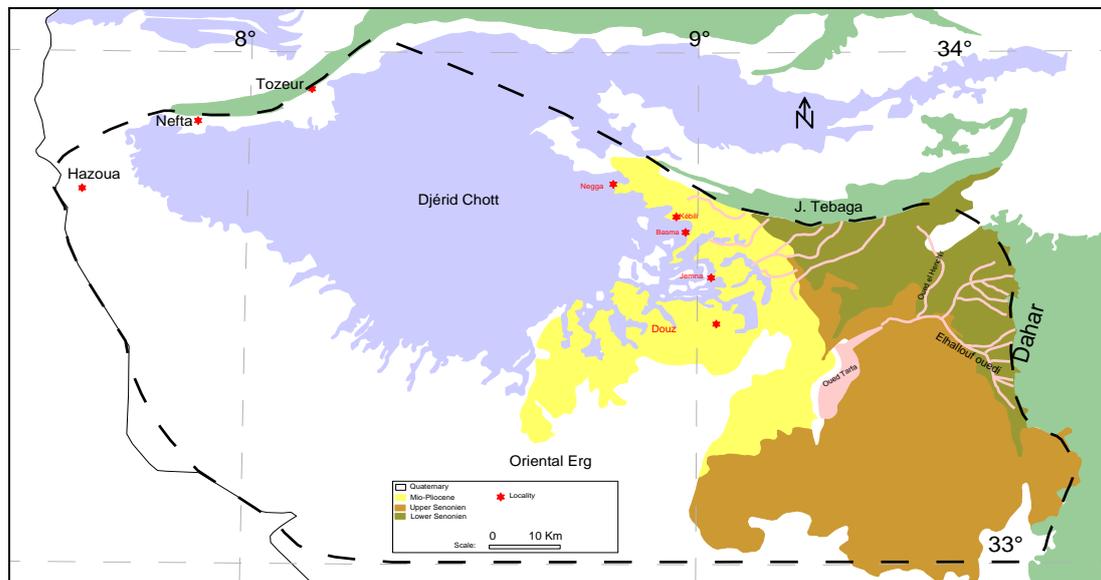
**Project Outcomes (Required):**

[The immediate benefit of changes resulting from the project’s outputs which relate to the achievement of the objective.]

Implementation of the project strengthened the national capacity to assess phreatic waters in southern Tunisia through the application of isotope tracers. Specifically, to characterize groundwater reservoirs in South Tunisia to better understand the hydrogeology and define their vulnerability to different external factors.

**General context**

The studied zone is located in the South-western part of Tunisia including the Nefzaoua region and southern Draa of Djérid region, its extends between 33°N and 34°N latitude and 8°E and 9°E longitude (Fig.1). It is characterized by very important fossil water resources lodged in Continental Intercalaire and the Complexe Terminal aquifer systems. Important shallow resources are also remains of local extension. Some shallow aquifers have been studied in terms on hydrogeolog, hydrochemistry and isotope hydrology issues in the Nefzaoua region . This study showed the existence of three types of groundwater: oasis aquifer, alluvial aquifer and underflows aquifer. Nevertheless, all these aquifers present strong mineralization continuously increasing mainly under the effect of overexploitation. This fact impose that a improved valorisation strategy of shallow aquifer has to be developing for the management of water resources in this area.



**Fig.1 Location of the studied zone**

**Results**

The hydrogeology study coupled to traditional geology approach allows to understand main features of the aquifer system in the Nefzaoua and in the southern Draa of Djérid: hydrodynamic factors, reservoir géométry, preferential recharge areas in the Tebaga of Kébili and in the Dahar borders for Nefzaoua shallow aquifers and in the Draa borders for the aquifers of the southern Draa of Djérid.

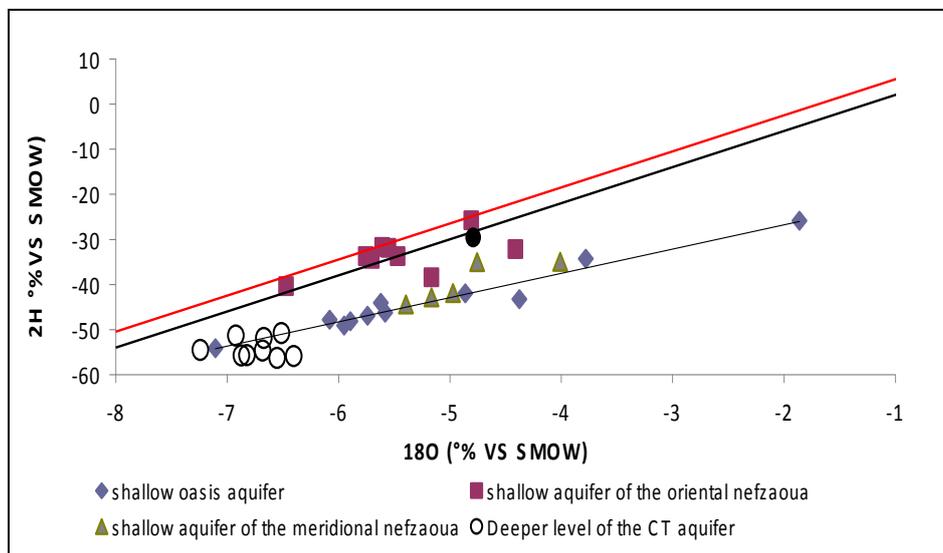
Geochemical data are presented in tables 1, 2, 3, 4, 5.

During 2008, a sampling campaign has concerned aquifers of Nefzaoua area with 36 points from

well water (shallow water) and 20 points from the Complexe Terminal system. During March 2009, sampling has concerned shallow aquifers in the Draa Djérid area with 18 points from well water (shallow water) and 20 points sampled from upstream and downstream drains. This campaign has been carried out also in March 2010 in order to follow temporal variations. During January 2010, sampling campaigns have mainly concerned the drainage water of the Nefzaoua area: 26 points have been sampled along upstream and downstream drains. Same points have been sampled in March 2010 in order to follow temporal variations and have been completed with 18 points from well waters in oasis area.

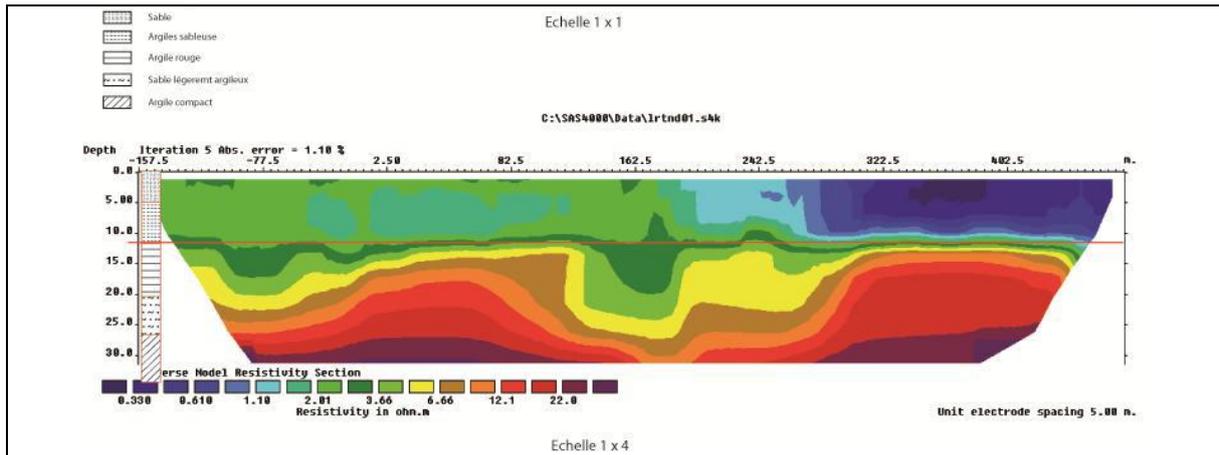
Mineralisation origin has been investigated through major elements distribution and relationships. First results trend to indicate that two main processes contribute to mineralization in deep groundwater: gypsum dissolution and cation exchanges with clay mineral. However, mineralization of shallow groundwater is controlled by different factors and needs more refined interpretations.

Stable isotopes analyses ( $^{18}\text{O}$ ,  $^2\text{H}$ ) have been plotted for waters sampled in 2008 from different aquifers of the Nefzaoua area (Fig.2). Several groups can be distinguished on which groundwater of the Complexe Terminal aquifer are well identified by “old” fingerprint. A second group constituted of shallow water sampled on the oriental side of the area Oriental Aoua indicate a recent recharge by local precipitation. The third group are points from oasis aquifer and meridional part of the seems to indicate a mixing process between two end-members: a end-member with “old” water fingerprint and a second en-member with an evaporated fingerprint. Further investigations will be carried out to detail this first remark.



**Fig.2 Plot of Oxygen 18 vs deuterium for Nefzaoua groundwater (Water sampled at 2008)**

The application of TER tools in the areas of Kébili and Douz shows the intrusion of a saline bevel from drainage basin towards groundwater of Douz (Fig.3). Thus, this intrusion can induce the loss of the oasis aquifer of long-term.



**Fig.3 Highlight of the intrusion of a saline bevel towards the oasis aquifer at Douz region**

**Remarks (Optional):**

The project was approved by the Agency to support national efforts in addressing a specific development problem of socio-economic significance. However, a limited funding has been supplied to the project. Although this fact, almost all project objectives have been achieved. Chemical analyses and stable isotopes measurement have been carried out in the Laboratory of Radio-Analyses and Environment. On the other hand, field trips and sampling campaigns have been also planned and realised by the LRAE in support with the local CRDA.

All data and results have been synthesised in technical report submitted to the local water managers and are currently prepared for scientific publications.