Using of Environmental isotopes to Improved Understanding of Wadi Samail Catchment Hydrogeology , Oman : A pilot study within the framework of the Enhanced Water Availability project (IWAVE)

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1. Introduction

In arid areas such as Oman, groundwater resources cover most of the demand and in some areas, they are the sole contributor. The subsurface geology of Oman is very complex and variable. In order to assess the aquifer system within this complex geology, isotopes seems to be the best tool to identify origin and dating of both surface and groundwater. The IWAVE project depended on collection of samples for stable and radioactive isotopes all over the sultanate. Oman being a large area, it was suggested as a starting point to confine the pilot study to be within one catchment, and Samail Catchment was selected for this purposes (**Figure 1**). The study is conducted between the Ministry of Regional Municipalities and Water Resources (MRMWR) Sultan Qaboos University (SQU) and Petroleum Oman Development (PDO) within the frame work of IWAVE project and the direct supervision of Peace Nuclear Techniques Office in Oman (PNTO). This Project had the following objectives:

- Improve the understanding of groundwater and surface water in this specific area by utilizing isotopes and radioactive data.
- Suggest future management directions in the study area..

2. Study Area

The Samail catchment lies southwest of the capital Muscat and extends some 65 Km inland from the Sea of Oman. The total land area is 1846 km2. Elevations range from greater than 2500 m along the western flank of Jabal Akhdar to 500 – 1000 m within the central upper catchment area, reducing to near sea level in coastal areas.Two distinct geomorphological zones are recognised:

- a mountainous upper catchment zone dominated by igneous rocks (Samail ophiolite) and flanked east and west by Jabals Hajar and Akhdar respectively, which mainly comprise sedimentary rocks of the Hajar Super Group (HSG).
- a coastal plain zone extending northwards from subdued carbonate ridges in the south, across an alluvial fan sequence to sabkha deposits near the coast.

3. Geology of the Study Area

The geology and structure of the area is shown on Figure 2.

Permian to Cretaceaous rocks belonging to the Hajar Super group (HSG) are exposed on the eastern and western margins of the basin and form a large synclinal structure hosting Hawasina and Samail nappe sequences.

The Samail Nappe is extensively exposed throughout the upper catchment area and consists of gabbro, basalt and dolerite and ultrabasic peridotites, harzburgite and dunite. It is characterised by intense fracturing and weathering.

post-Nappe Tertiary listwaenite (carbonated peridotites) outcrop near Fanjah, and trend northwest - southeast across Wadi Samail into adjacent catchments.

Valley-fill alluvium of late Tertiary to Quaternary age lines upper catchment wadi channels. Sediment thickness is generally less than 50 metres. Near the coastal area drilling indicates an alluvium thickness of greater than 350 m.

4. Methods

For better understanding of the study, total of 79 samples were collected from groundwater of Samail Catchment in three main campaigns between December 2012 to January 2015). These samples covered 52 location distributed as following: (19) BHs, (22) Dawoodi aflaj, (5) Ghaili aflaj, (2) dug wells and (4) springs. The analysis of samples has been conducted in Oman for chemistry and I A EA, Vienna for stable isotopes.

5. Results

Data analyses for Oxygen-1 8 and Tritium shows two types of rainfall are occurred in the upper catchment, depleted rainfall in western side and enriched rainfall in the eastern side Both data were shown disconnected of isotope signature in middle of the catchment then appear again in the lower part, with similarity in the upper to that in the lower catchment suggested subsurface flow. Moreover the existing of Tritium and Carbon-14 enrich near the Oman Sea with almost equivalent values to those found in upper catchment m ay reflect a quick movement of recharge.

Water samples from Falaj systems scatter around the global meteoric water line (**Figure 2**), whereas the groundwater samples from the alluvium and Ophiolite aquifers show the effect of evaporation. Such evaporation takes place from the wadi following the flash floods which might suggest recharge from stream bed. Boreholes located in shallow aquifers are influenced by evaporation and therefore they shifted from GMWL towards positive side of X access.

High ^{14}C content has been recorded (in the range of 69.6 – 109.4 pmc) in wells and two Falaj located across the catchment, suggesting modern recharge throughout the catchment, which is also supported by the tritium value that will be discussed later. The lowest ^{14}C value (30.6 pmc) is from the well (AGS-5HS)located close to Oman Sea tapping water from the bottom of the alluvium at depth of 185 m, which might suggest that this water is a trapped paleo-water.

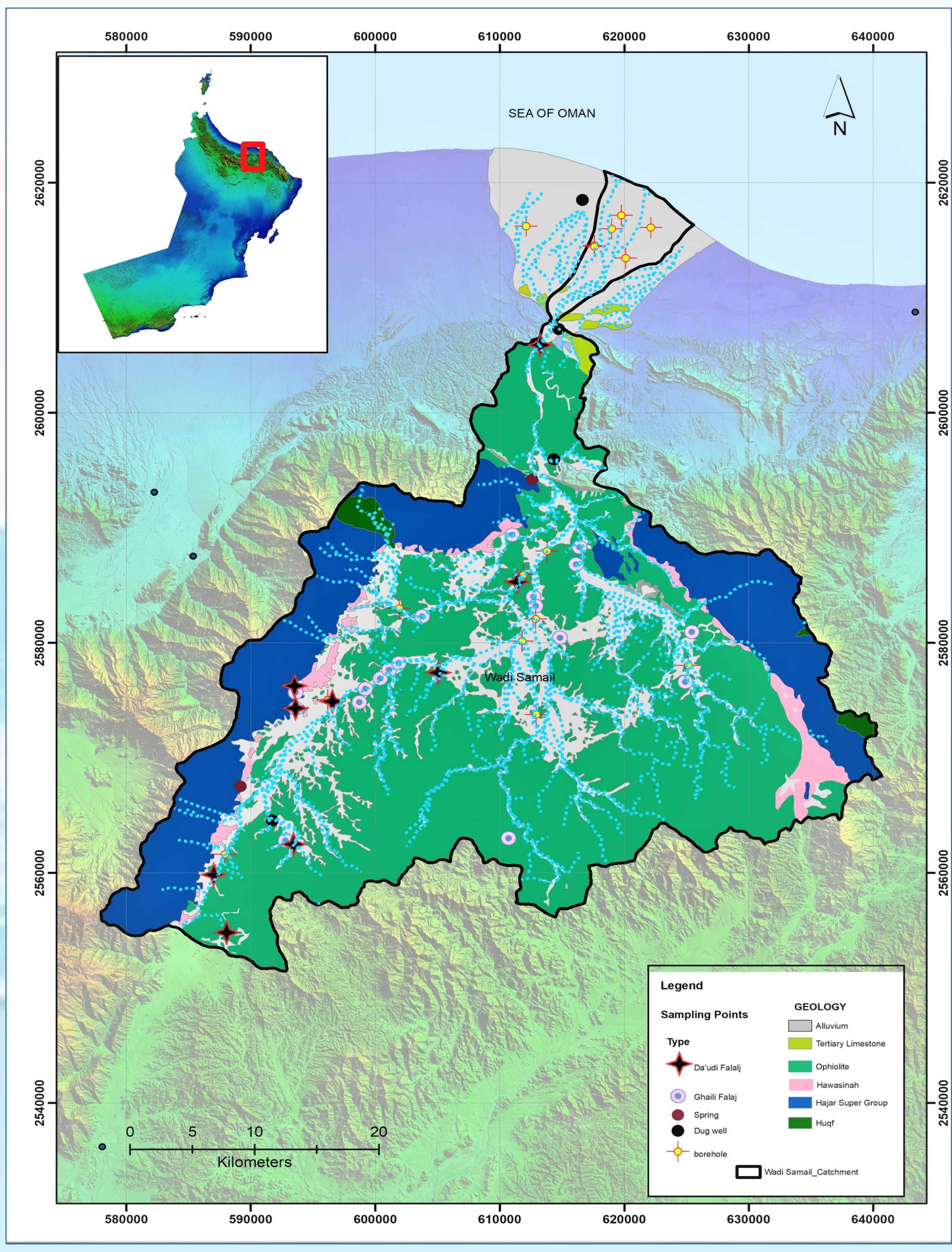

Figure (1) show the study area, the Geology and the Sampling Points

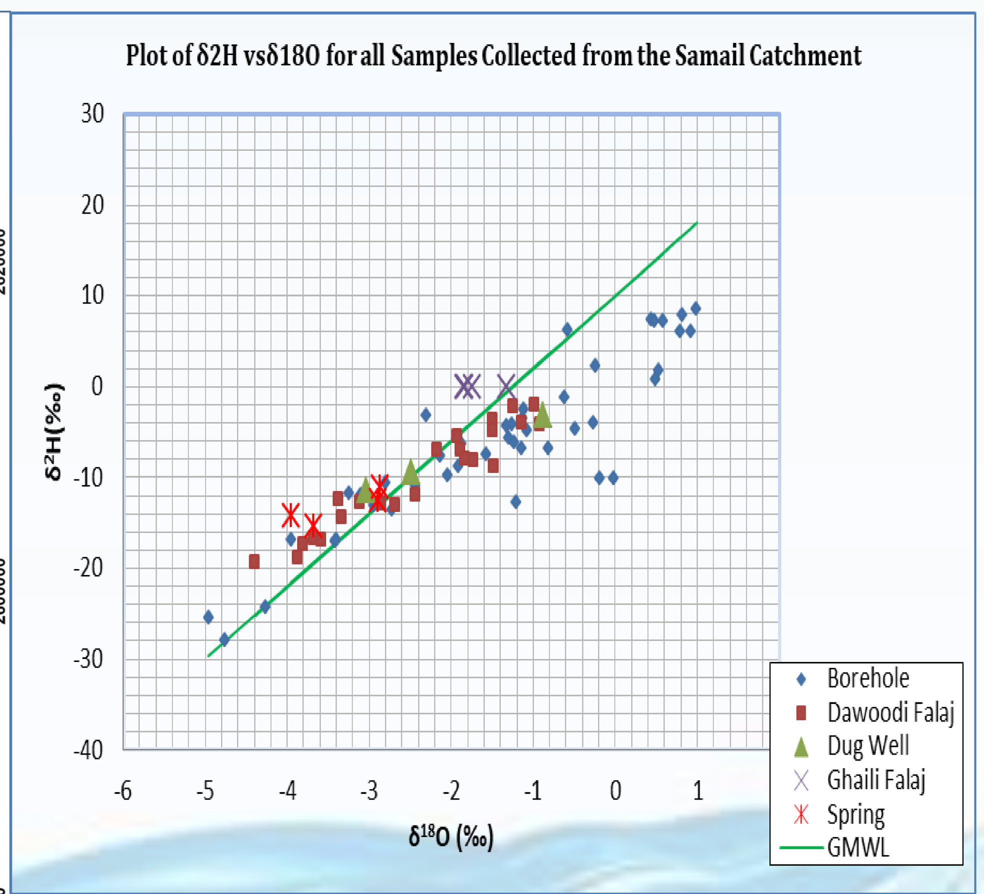

Figure (2): Plot of δ2H vsδ18O for all Samples Collected from the Samail Catchment

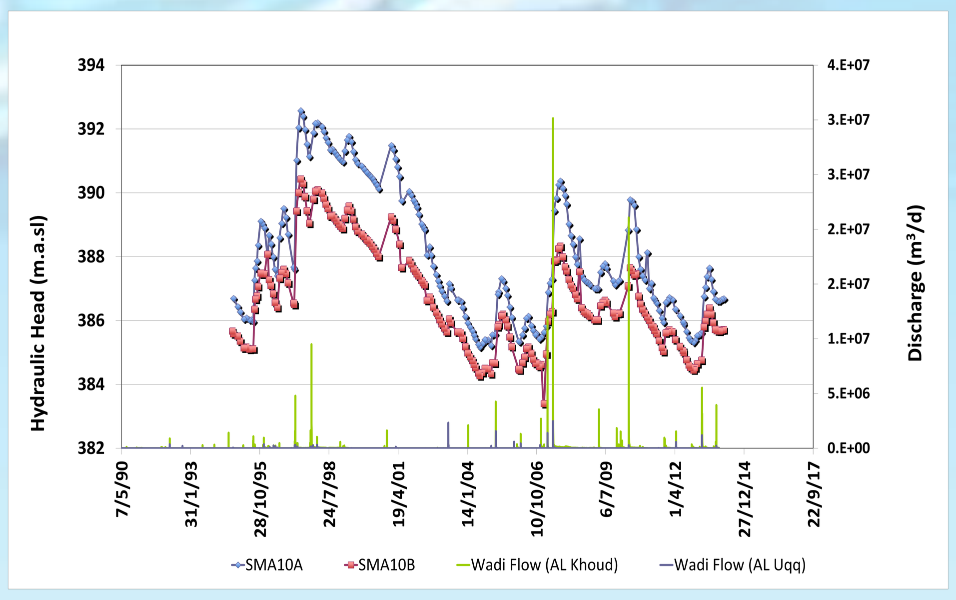

Figure (3) show Selected Monitoring wells Hydrographs vs Wadi Flow

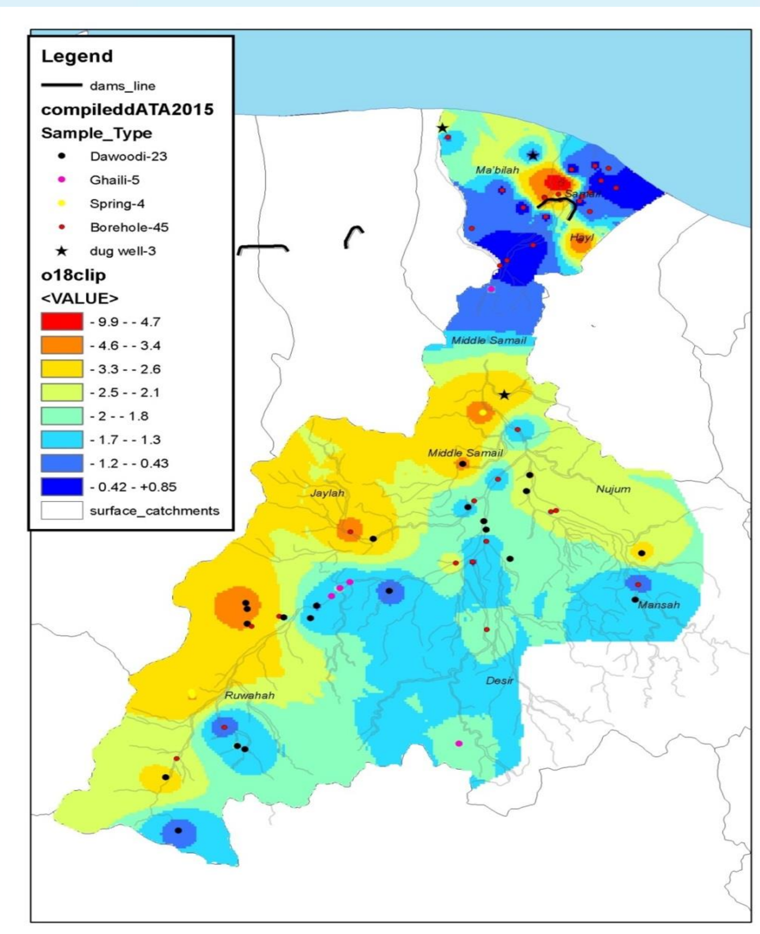

Figure 4. Distribution of 18-O for all samples

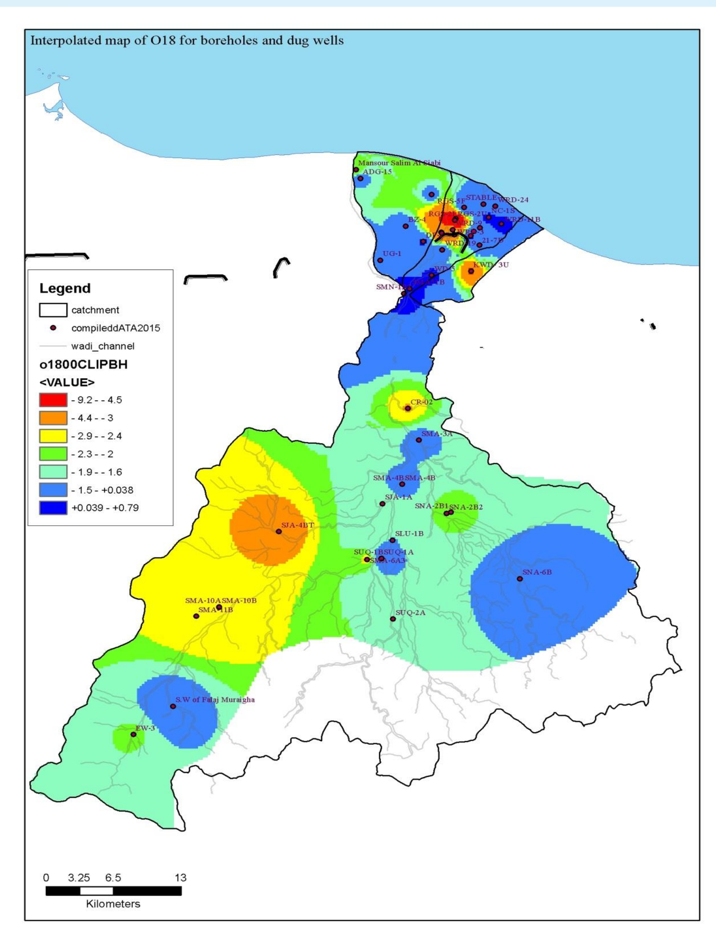

Figure 5. Distribution of 18-O for boreholes and dug wells

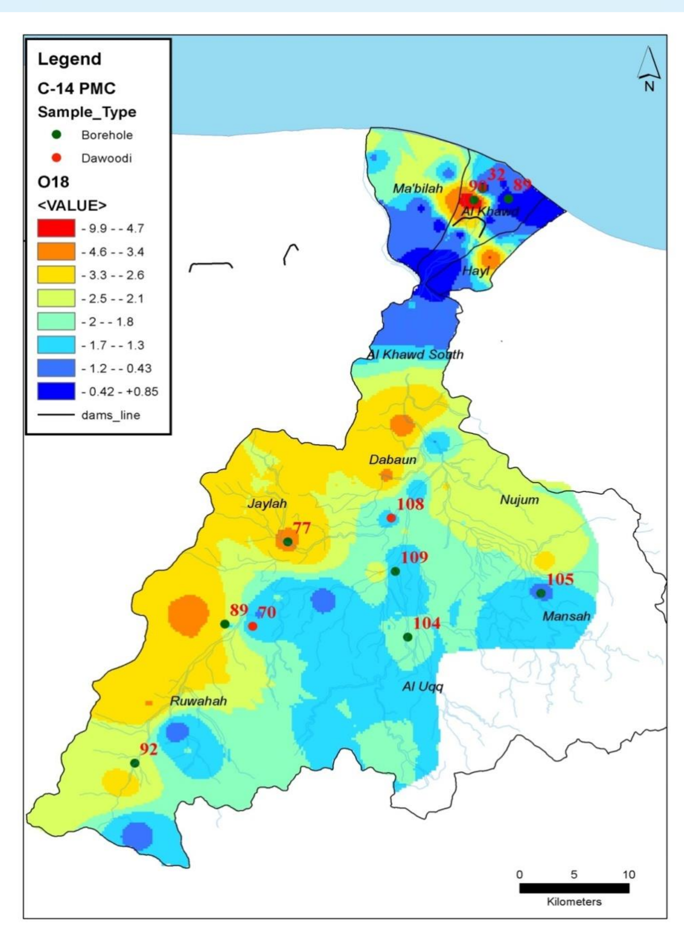

Figure 6. Carboon-14 (Numbers in red) and Oxegen-18

6. Conclusion

- Groundwater is demonstrate by altitude effect producing depleted Oxygen-18 in Aflaj, springs, boreholes and dug wells of the upper catchment higher in western side than in eastern.
- Subsurface recharge between upper and lower of samail catchment is significant, this confirmed by highly depleted Oxygen-1 8 near Oman Sea, Tritium and Carbon-1 4 data with high values appearance in the lower catchment suggesting quick recharge.
- There is some similarity in the stable isotopic compositions in the upper catchment between the samples from boreholes, dawoodi a flaj and springs and thus may suggest, these samples sharing the recharge from same source of water, dominantly direct recharge from rains.
- Tritium and Carbon-14 data with high values in the upper and lower catchments suggesting a quick or recent recharge.

7. References

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