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Factors affecting the stable isotopes ratios in groundwater impacted by intense agricultural practices: A case study from the Nile Valley of Egypt

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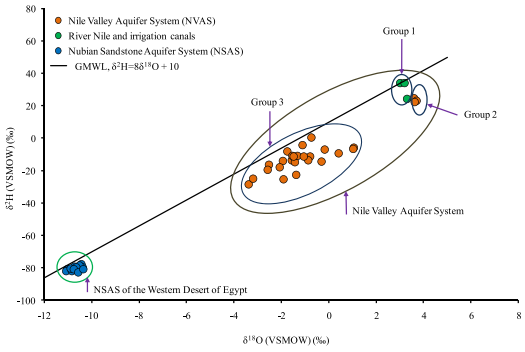
HIGHLIGHTS

- Stable isotopes were used to study groundwater/surface water interaction.
- The study area in Egypt which is in arid climate zone.
- The study area is under intense year-long agricultural practices.
- The study estimated the evaporative loss and it is implication on water management.
- This is the first study of its kind from the study area.

GRAPHICAL ABSTRACT



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ABSTRACT

The monitoring of stable isotopes ($\delta^{18}O$ and $\delta^{2}H$) in water can provide a sensitive indicator of water loss by evaporation. We obtained water samples from surface water and groundwater from both the young and old alluvial plains in the central part of the Nile Valley of Egypt. Groundwater is the only source for irrigation in the old alluvial plains while both surface water (River Nile and irrigation canals) and groundwater are used in the young alluvial plain. Results showed different isotopic compositions between each group of samples and hydrologic connections between shallow groundwater and surface water in the young alluvial plain. The $\delta^{18}O$ and $\delta^{2}H$ relationship of the samples collected from the desert areas of the old alluvial plains below agricultural lands define an evaporation line with a slope of 4.5 and low deuterium excess of <— 14‰. These values can be attributed to return flow of irrigation water that has been subjected to evaporative processes, further amplified by intense agricultural practices. Average evaporative losses were estimated to be between 31% and 36%.

1. Introduction

The Egyptian terrain is covered by a vast desert plateau interrupted by the Nile Valley and Delta, which occupy a small percentage of the total area of the country. The Nile Valley divides Egypt geographically into what is called the Eastern Desert, bounded by the Red Sea and Gulf of Suez in the east and the Western Desert, which stretches to the

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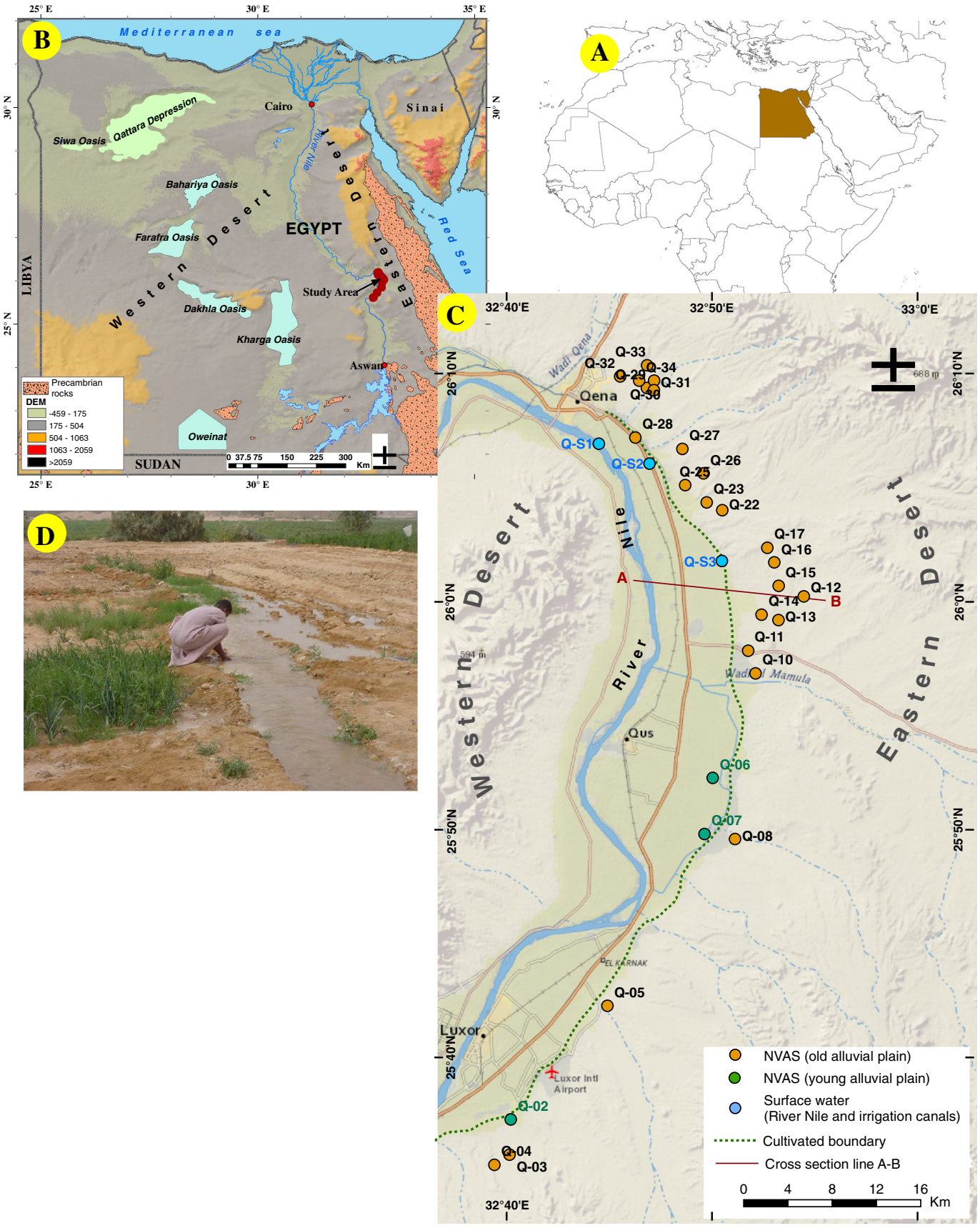

Fig. 1. Overview figure for the study area. (A) Location of Egypt. (B) Physical map of Egypt, showing the location of the study area (after Mohammed, 2015). (C) Detailed map of the study area in Qena, Egypt, showing the sample locations (source, Free ArcGIS base map sources). (D) Field photo showing the irrigation practices in the study area.