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Importance of remote sensing data in investigating the potential groundwater zones in semi-arid area

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INTRODUCTION & AIM

In semi-arid regions, and more particularly in the crystalline and crystallophyllous basement zones, geological mapping and the spatial distribution of fracture networks are of vital importance for prospecting and exploiting groundwater resources. In this respect, studies have shown that the analysis of data from remote sensing techniques coupled with field observations is a relevant approach for generating accurate litho-structural maps (Miyouna and al., 2020).

The aim of this study is therefore to highlight the most appropriate processing of Landsat 8 OLI satellite images in order to extract the maximum amount of lithological and structural information required to produce a detailed and accurate geological map. The map resulting from this study could therefore be an important scientific document for guiding aquifer prospecting, with a view to better targeting the areas for future water drilling in the crystalline and crystallophyllous basement of the Tagragra of Akka inlier.

Geological context of Study area

Part of the Western Anti-Atlas, the Tagragra of Akka inlier, which is the subject of this study, is located approximately 260 km south-east of the town of Agadir. From a geological point of view, it is composed of a sedimentary cover formed essentially by terrains of terminal Neoproterozoic and Palaeozoic age, resting in major unconformity on a basement of lower Proterozoic age, composed of metamorphosed schists and grauwackes intruded by granitic massifs (Choubert 1963) (figure 1). These basement formations are traversed by dolerite, gabbro, diorite, quartz diorite and rhyodacite dyke (Benbrahim and Aissa (2005) .

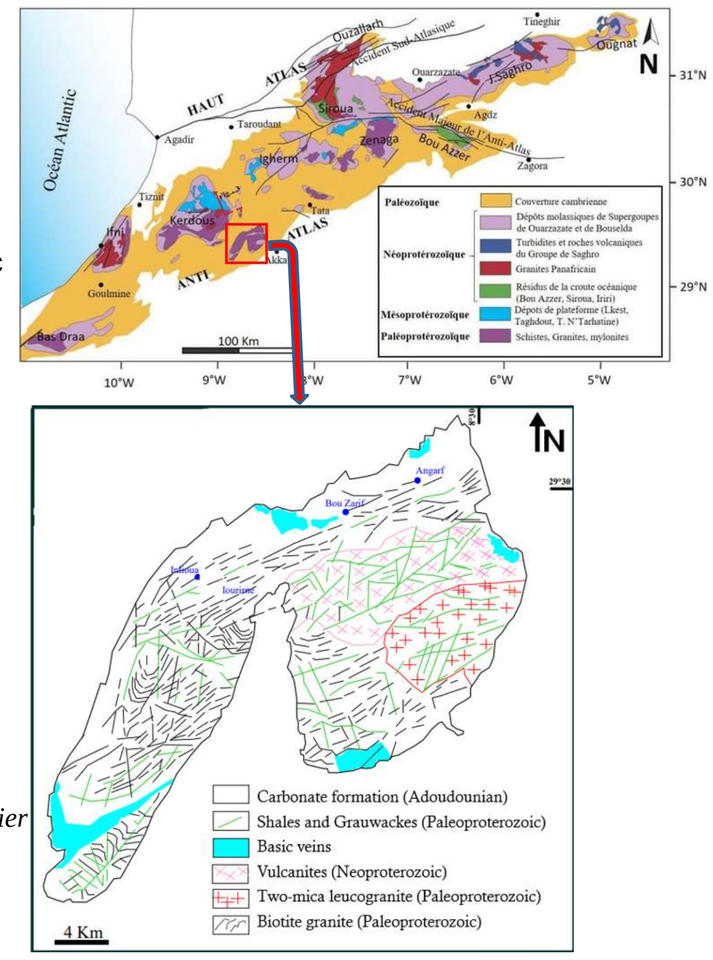


Figure 1. a) Location of Tagragra of Akka inlier . b)The pre-existing geological map of the Tagragra of Akka inlier; Choubert (1963).

METHOD

The realization of this work required the use of data composed of satellite images, pre-existing geological maps and data collected in the field. The Landsat 8 OLI images were chosen because of their spectral and spatial characteristics allowing a good litho-structural mapping at small scale Scanvic (1994). Auxiliary data include the geological map of the Tagraga of Akka inlier established by Choubert (1963)(figure1) and used during the field mission and for litho-structural analyses of the satellite images.

To achieve the objectives assigned to this work, the methodological approach adopted consists of the crossing and superimposition of different layers of geological information (figure 2).

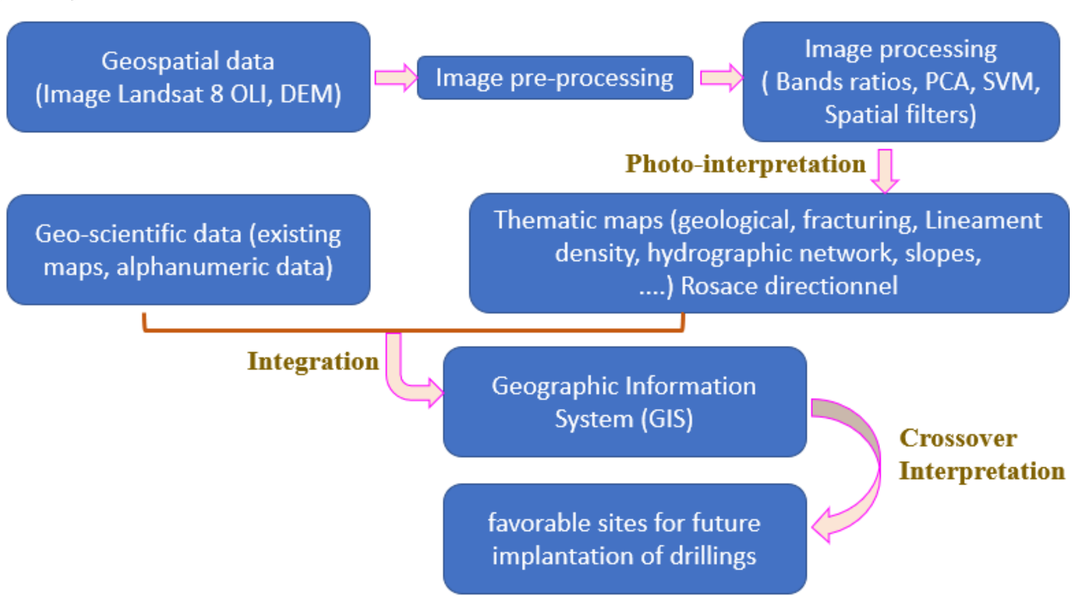
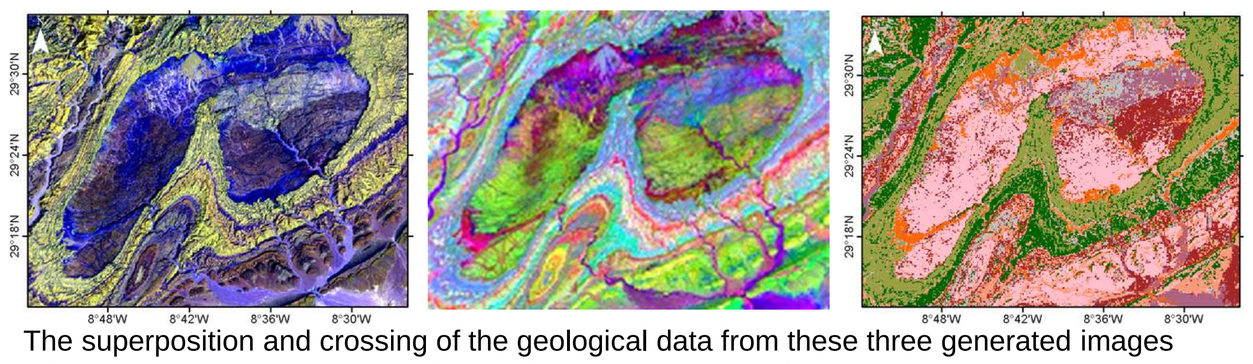


Figure 2: Main stages in the methodology adopted.

RESULTS & DISCUSSION

In order to detect as much geological information as possible about the lithology, several image processing algorithms were tested, to retain only the (a) color composition (RGB=751), (b): PCA principal composition analysis (RGB=521), (c): SVM classification, where the different litho-stratigraphic units and lineaments are well individualized. (figure 3).



The superposition and crossing of the geological data from these three generated images allowed to draw up a more detailed geological map (figure 4)

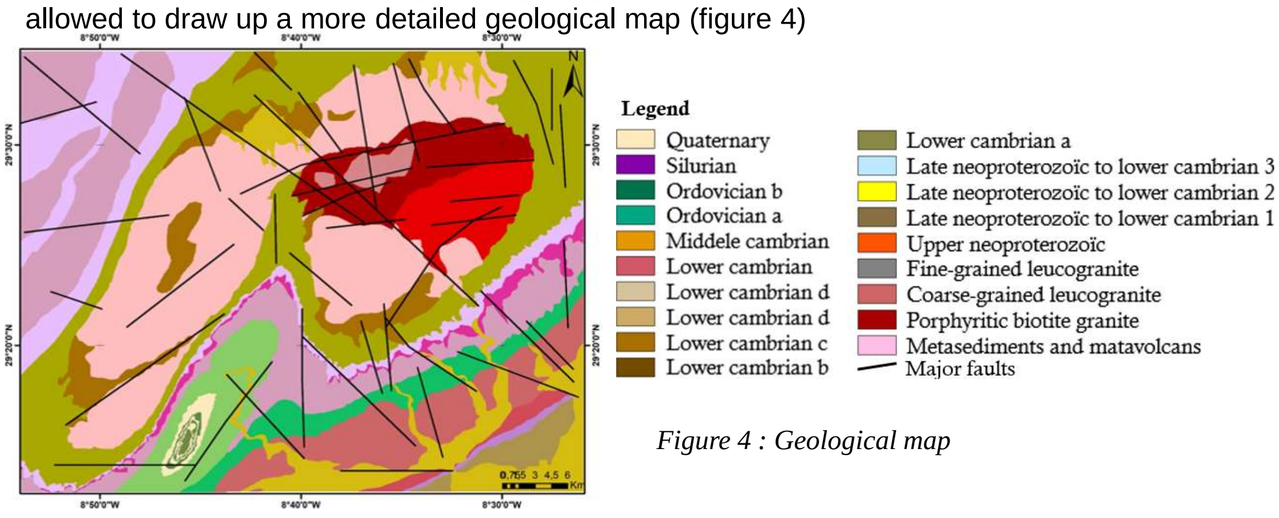


Figure 4 : Geological map

For identification of the main lineaments, the manual extraction method by photo-interpretation was preferred in this study because of its ability to differentiate lineaments of natural origin from those of anthropogenic origin (roads, tracks and wires) (figure 5).

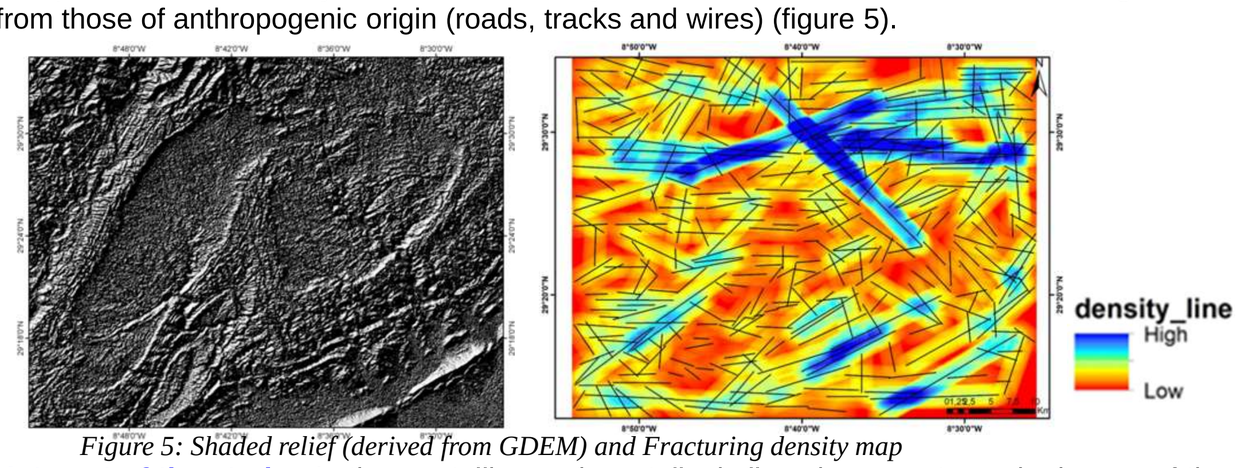


Figure 5: Shaded relief (derived from GDEM) and Fracturing density map

Interest of the study : In the crystalline and crystallophyllous basement, cracked, case of the Tagragra of Akka inlier, previous works consider that the fractures constitute the main flow paths of groundwater. In this context, the map of tectonic lineaments (faults, fractures ...) of this inlier has allowed at least the identification of highly fractured areas where water infiltration is very important. These areas can be considered as indicators of aquifer potential. Thus, the highly fractured zones represent favorable sites for future drilling.

However, the cartographic identification of highly fractured zones does not guarantee a 100% success rate for drilling, even if the probability seems strong. But, it will at least allow to avoid the exploration of the all territory and to focus the research only on the sectors with promising aquifer potential.

CONCLUSION

The application of different satellite image processing techniques, based on a Landsat 8 OLI scene, has been very effective in lithological and lineament mapping. These tele-analytical maps (lithological and fracturing maps) will be of capital importance for future prospecting and exploitation of natural resources in general and groundwater in particular. Thus, the lineament map provides an overview of the spatial distribution of major accidents and areas of high fracturing concentration. These intensely fractured zones are characterized by a strong infiltration of surface water, and constitute a good guide for hydrogeological research in the basement formations. Therefore, they are considered to be suitable locations for future drilling because they have good and excellent groundwater availability.

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