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Geological and Hydrothermal Outlines of the Tunisian Fluorine Province (North-Eastern Tunisia)

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ABSTRACT

Compilation and treatment of geological, hydrostratigraphical, geophysical and hydrogeothermical information's are very important to assess natural resources of the sedimentary basin which is characterized by its extension, geology and hydrodynamism.

Hydrochemical investigation is necessary to more understanding the relationship between thermal circulation, mineral deposits and the water – rock interaction. The chemical composition of the thermal waters seems to be controlled by the Triassic evaporate and influenced by the mineral deposits. Especially, the Fluorite deposits result from hydraulic fracturing and suggest the presence of active hydrothermal system and high temperatures in deep aquifers.

The studied area is located in the province of Zaghouan in North Eastern Tunisia. This part of the Tunisian Atlas is characterized by geothermal springs and several mineral deposits (F, Pb, Zn, Ba).

The main aim of this study is to establish the origin of thermal springs, their relation with the geological and structural settings of the area and the relationship between hydrothermal waters and mineral deposits. Structural studies show that the thermal emergencies are essentially controlled by tectonics and halocinetic movements.

Thanks to geological, geophysical, hydrochemical, geothermal and geothermometric approaches carried out in the studied area, it was possible to identify the potential reservoirs. Among these, the Jurassic limestone seems to be the most promising reservoir of thermal waters. The study of Jurassic aquifer in North Eastern Tunisia, particularly in Zaghouan basin, reinforced the plausible genetic linkage idea between hydrothermal and mineral deposits.

1. INTRODUCTION

The Tunisian Fluorine province has a complex geology and presents diverse secrets and potentialities in natural resources. The North-Eastern part is characterized by different thermal springs which distribution is essentially controlled by the tectonic fractures and by the diapirs ascent. This area is also characterized by the abundance of mineral deposits (Pb, Zn, Ba, F) especially the fluorite.

The compilation and treatment of geological, geophysical, hydrochemical, geothermal and geothermometric data, allowed having a clear idea about the origin of thermal springs, their relation with the geological and structural settings of the area and the relationship between hydrothermal waters and mineral deposits.

2. GEOLOGICAL SETTING

The studied area is located in central North-Eastern Tunisia called the Tunisian Fluorine province. It is characterized by mineral deposits, especially fluorite ores and by hydrothermal emergencies. The distribution of the different springs is controlled by the tectonics fractures.

The fluorine province shows a lithological succession from Triassic to the Quaternary. We note particularly the presence of Jurassic appointments and Triassic evaporitic extrusions. So the hydrostratigraphical column reveals that the Jurassic limestone seem to constitute the most important potential reservoir aquifer in this region. The Jurassic outcrops are located along Zaghouan accident (Hammam Jedidi, Hammam Zriba and J. Oust…) (Fig. 1).

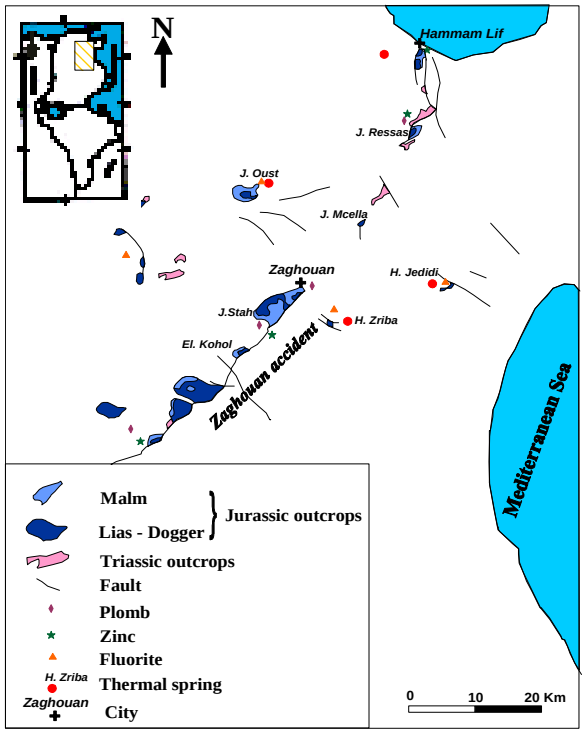

Fig 1: Location of the studied thermal springs and the mineral deposits in the Tunisian Fluorine Province.

The regional tectonic seems to be responsible of the diapiric ascent, and of the structuration of the region in a succession of horsts and grabens. These geological structures can constitute the main hydrogeothermic basins.

3. MINERALISATION

Mineral deposits in North-Eastern Tunisia represent a big economic interest. The Tunisian Fluorine province is characterized by the abundance of mineral deposits especially Pb, Zn, Ba and F associated with chalky facies,

which are considered as an important source of ore deposits (Sangster, 1976). The Aptian-Albian hosted rocks are an important feature for these deposits (Amouri, 1989) which localization and stratigraphic setting are the result of tectonic movements and diapirism. The mineral concentration results from fractures and karsts fillings.

The Tunisian fluorine province is characterized by the presence of Jurassic outcrops along Zaghouan accident. This major fault is responsible of the contact between Jurassic and Triassic outcrops (Fig1).

Jurassic mounts are exposed owing to extrusive tectonics, they constitute horsts and correspond to positive paleostructures (Florida, 1973); they are the origin of mineral concentration. In general, Jurassic outcrops are rich in Pb, Zn, Ba and fluorite. The distribution of primary mineralization is controlled by tectonic movements, geochemistry, hydrogeological and especially the diapirism that seems to be a determining factor in the development of metal concentration. The ore deposits are distributed generally around the salt bearing Triassic outcrops and they are located near the thermal springs (Jallouli, 1981). We note the existence of a relationship between the mineralization, the Jurassic extrusion and the Triassic evaporitic ascent movements.

The studied area is characterized by the dominance of fluorite-celesto-baryte ores (J. Bou kornine, J. Ressas, J.Mecella, J. Oust, J. Kohol, Hammam Zriba, Hammam Jedidi).

All mineralization is located in tow part of stratigraphic column of the Jurassic: in lower Lias and terminal Jurassic (Solignac, 1973).

Mineralization results from hydrothermal circulation which is responsible of the extension of karsts and fractures. There are different types of mineralization, as the karstic and the peneconcordant ores that is present in Hammam Jedidi and Hammam Zriba (Fig 2).

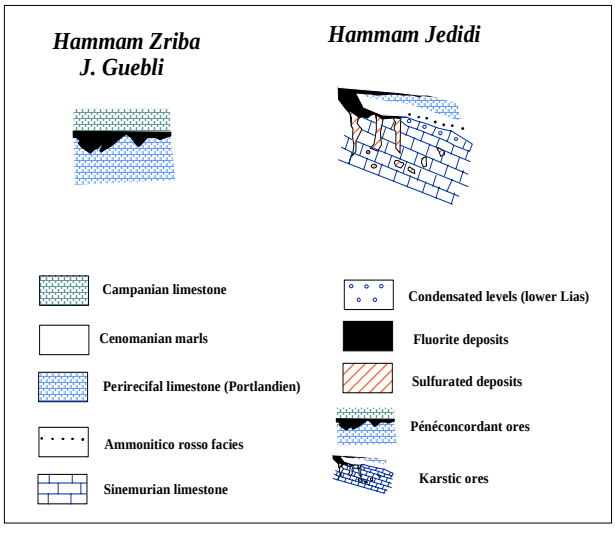

Fig 2: different types of mineral deposits in the Tunisian Fluorine Province.

In the studied region, the fractures, karsts structures, extensions of the rocks and faults have given rise to the formation of several hydrothermal circulations responsible of the mineral concentrations (Gemici and Filiz, 2001).

4. HYDROCHEMICAL STUDY AND DISCUSSION

An investigation of hydrochemical composition of waters from North-Eastern Tunisia has been carried out to identify the origin and evolution of thermal springs and their relation with mineral deposits and the impact of diapiric structures. Sampling concerned the warm springs of the region; the temperatures are about 46°C and 64°C respectively in Hammam Zriba and Hammam Jedidi.

In Hammam Jedidi and Hammam Zriba, geochemical study shows that thermal waters are mainly of Na-Cl type probably due to the Triassic halite dissolution. Chloride and Sodium constitute the major anion and cation in these waters. In fact, the Cl-SO_4-HCO_3 diagram (Giggenbach, 1991), shows the enrichment of the waters in Na and Cl. The waters of H. Jedidi and H. Zriba are respectively enriched in Potassiumb in Sulphate and Calcium (Fig 3).

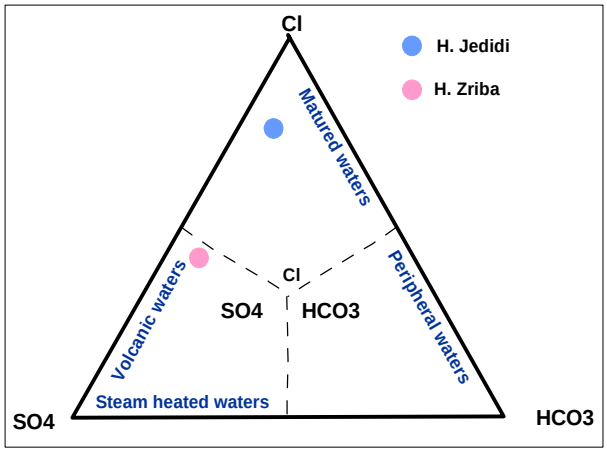

Figure 3: Cl-SO_4-HCO_3 diagram applied to studied waters

In the other side, the Na-K-Mg Diagram (Giggenbach, 1986) can give an idea about the waters thermodynamic equilibrium. The thermal waters of H.Jedidi is located near the ligne of total equilibrium but those of H. Zriba plot in the group of peripheral waters indicating a non equilibrated fluids or a mixing with superficial waters (Fig4).

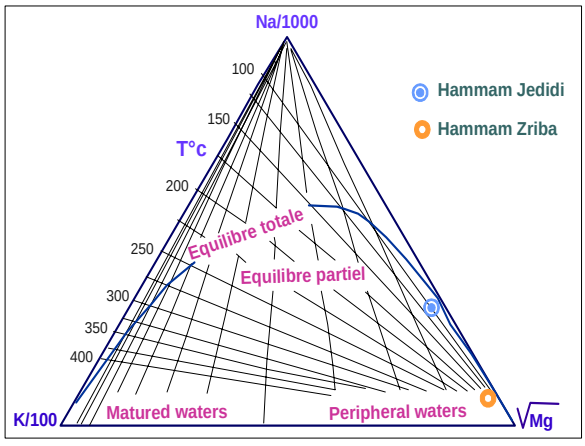

Figure 4: Na-K-Mg diagram applied to studied waters.

The groundwater's enrichment in Na and Cl is generally due to the dissolution of evaporitic minerals present in sediment**.** So, the halite dissolution seems to be the main source for the sodium and chloride in studied waters. The evaluation of the degree of water-rock interaction reached by each sample

allows us to establish whether these waters have been in equilibrium with a mineral phase (Sadki, 1998; Gemici and Filiz, 2001).

5. RELATION BETWEEN MINERAL DEPOSITS AND HYDROTHERMAL CIRCULATION

The geochemical study of thermal features such as thermal springs, provide many information about a geothermal system and mineral deposition.

In Tunisian Fluorine province, the majority of thermal springs emerge near halite and fluorite-Baryte deposits. The mineralization is essentially dependent of the water circulation, the temperature and the chemical dissolution in the reservoir. For this reason, the mineral deposit can originate from hydrothermal with the contribution of Triassic evaporitic diapirs (main source for the sodium and chloride), in the saline groundwater (H. Zriba).

Two hypotheses are suggested about ore concentration:

- Minerals deposits occur at the surface of several active hydrothermal systems where they have deposited from ascending thermal water.
- Water mineralization may be come from minerals deposits.

CONCLUSION

The Tunisian Fluorine province is characterized by Jurassic outcrops, hydrothermal springs and mineral deposits.

Tectonic activities are generally associated to Triassic ascent. Based on the geological features and the interpretation of hydrochemical data, it is suggested that reservoirs are represented by the different Jurassic fractured limestone, which constitutes the most important regional aquifers. Thus, the structuration of the aquifers is closely influenced by the diapirs ascent.

Chemical analyse's interpretation provides evidence for hydrothermal circulations, the mineral concentrations and the strong influence of mineral and evaporitic deposits (fluorite) during water ascent from deep reservoirs to the surface.

The compilation of geological and hydrochemical data, permit to identify the relation between the hydrothermal and the mineralization of studied waters in North-Eastern Tunisia.

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