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Inventory and enhancement of geological heritage in the Ouzoud syncline (M'Goun UNESCO Geopark, Central High Altas, Morocco): first step for promoting geotourism and sustainable development

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INTRODUCTION

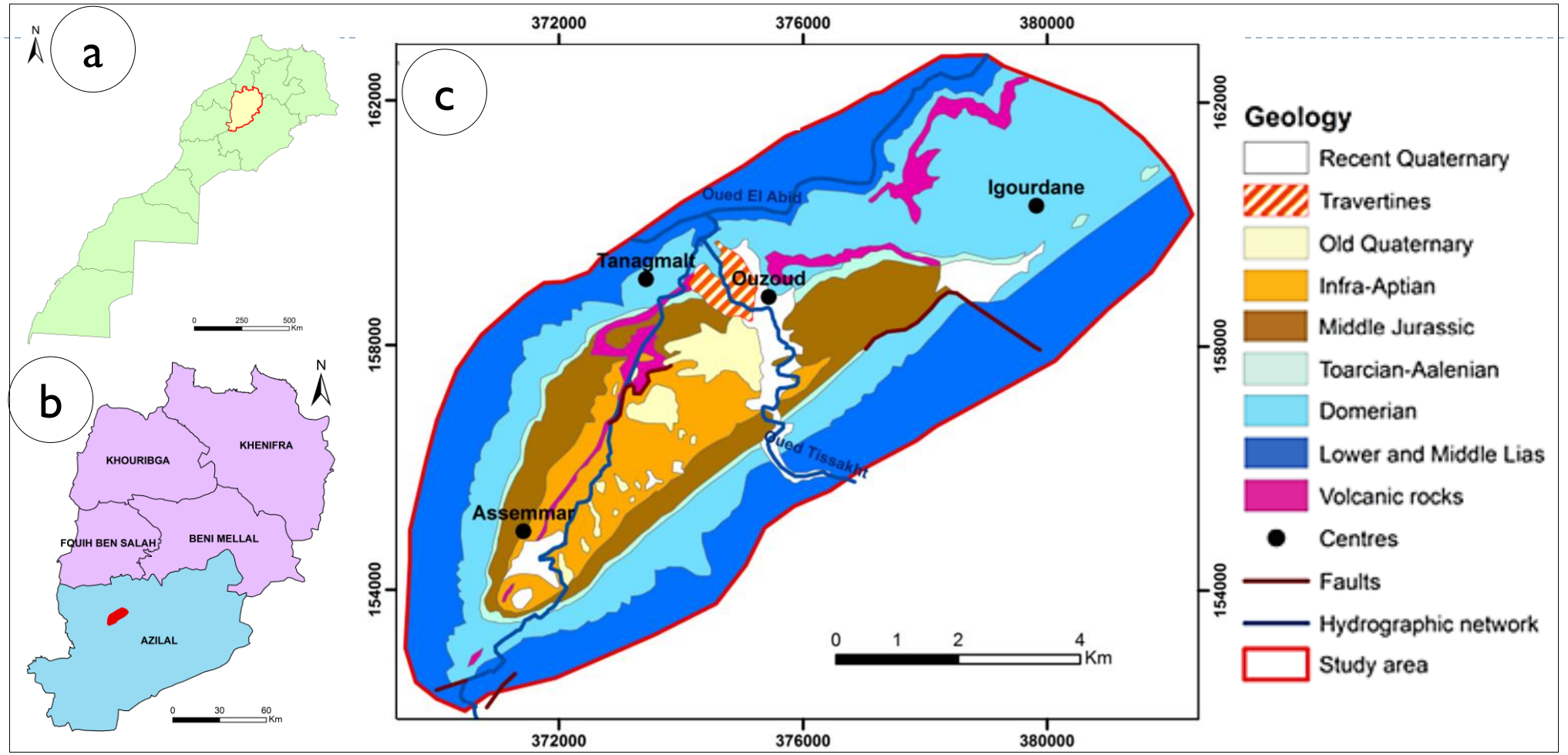
- The Béni Mellal-Khénifra region has an important geological heritage both by its richness and diversity.
- These important geosites have become in recent years an attractive areas for tourists, especially foreigners.
- a large part of this geological heritage is still unknown and under-exploited by managers.

OBJECTIVES

- Highlighting the geological heritage of Ouzoud syncline through an inventory supported by a quantitative assessment

- Increase the local tourism attraction by enhancing the geotourism and educational potential

STUDY AREA



a) Geographical situation of Beni Mellal-Khenifra region in the centre of Morocco; b) Geographical situation of the study area in Beni Mellal-Khenifra region; c) Geological map of study area extracted from geological map of Afourer 1/100000 and Azilal 1/100000

METHODOLOGY

Identify all sites of geological interest	Collect and enter their characteristics in the form of technical sheets	Prioritize and validate sites with high heritage value	Assess their vulnerability with a view to proposing protective and promoting measures
➢ **In-depth bibliographic analysis** ➢ **Geological literature review**	➢ **Detailed description** ➢ **and field investigation** ➢ **GPS data** ➢ **Taking photos**	➢ **Consulting with experts** ➢ **Quantitative assessment of** • **Scientific value** • **Additional value**	➢ **Assessment of use and management characteristics** ➢ **integrate these sites into territorial development as:** • **Touristic destination** • **Educational outings**

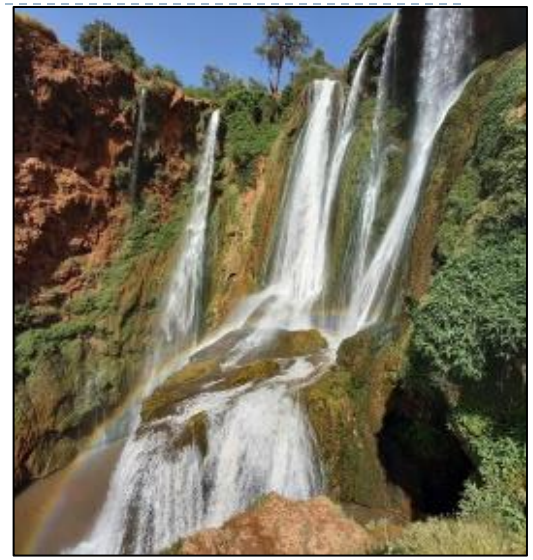
According to Reynard (2016) methodology

RESULTS AND DISCUSSION

1. The dolerite sill of Ouzoud

It is a greenish dolerite layer of Lower Cretaceous age which intrudes the massifs limestones of the Dogger.

The most spectacular fall is about 110 m high at the bottom of a chasm covered with beautiful travertine concretions



2. Ouzoud waterfalls

4. The estuary of Oued Tissakht

These concretions result from the precipitation of calcium carbonates dissolved in the river water

Tissakht watercourse descends quickly among limestone cliff covered with travertine. The rapid flow between these structures forms a turbulent eddy within the Giant's kettle

3. The Ouzoud travertines

RESULTS AND DISCUSSION

6. Azilal Fm intruded by the Tanaghmelt sill

it is a doleritic sill that cuts the reddish-brown marls of the Azilal Fm, leaving traces of contact metamorphism

It is an exceptional geomorphological forms carved out by the Oued El Abid river , forming a deep valley that exceeds 100 m.

5. The Oued El Abid Gorges

8. Ouzoud springs

there are 22 springs, which gush out through a complex karstic system formed by Liasic carbonates

associated with the upper part of the Iouaridène Fm, which corresponds to the second magmatic outpouring B2 of the Lower Cretaceous

7. The basaltic flows of Ouzoud

RESULTS AND DISCUSSION

Quantitative assessment of scientific and additional value of inventoried geosites (According to Reynard et al. 2016)

Geosites		Scientific value					Additional value			
Code	Name	Int	Rep	Rar	Pal	**Sci Val**	Eco Val	Aes Val	Cul val	Add Val
OUZmag001	Doleritic sill of Ouzoud	0.75	0.75	0.5	1	**0.75**	0.62	0.87	0.25	0.58
OUZhyd002	Ouzoud waterfalls	1	1	1	1	**1**	0.87	1	1	**0.96**
OUZkar003	Ouzoud travertines	1	1	0.5	1	**0.87**	0.87	1	0.75	0.87
OUZflu004	Estuary of Oued Tissakht (Ouzoud caves)	1	1	0.75	0.75	**0.87**	0.5	1	0.5	0.66
OUZgem005	Oued El Abid Gorges	1	1	0.75	0.5	**0.81**	0.5	1	0.5	0.66
OUZmag006	Chocolate marl intruded by Tanaghmelt sill	1	1	0.75	0.75	**0.87**	0.5	0.75	1	0.75
OUZmag007	Basaltic flows of Ouzoud	0.5	1	0.5	0.75	**0.69**	0.5	0.5	0.25	**0.42**
OUZkar008	Karstic spring of Ouzoud	0.75	1	0.75	0.5	**0.75**	0.87	0.75	0.75	0.79

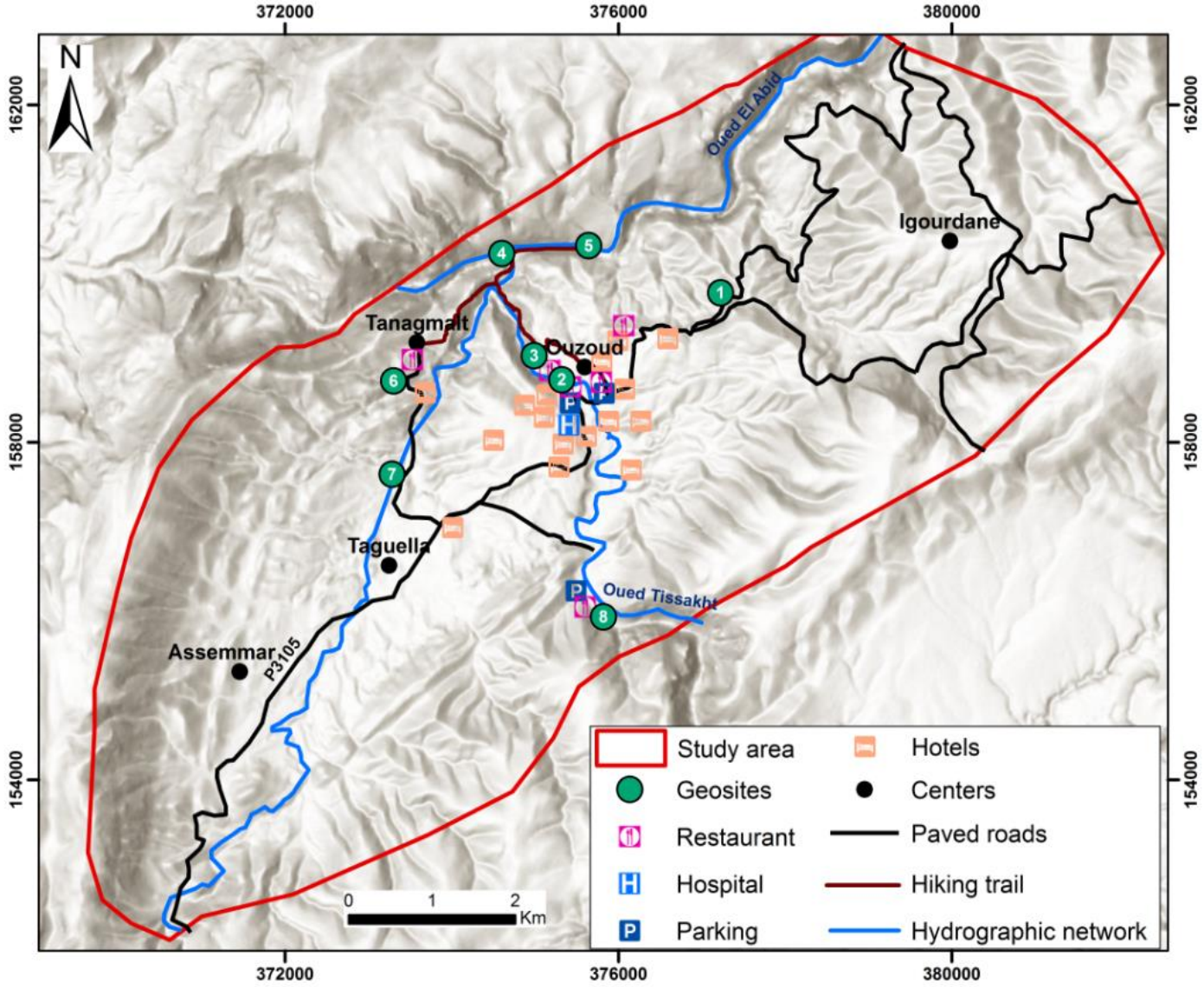
RESULTS AND DISCUSSION

Quantitative assessment of use and management value (Reynard et al., 2016 ; Louz et al., 2022)

Geosites	Use and management values					
	Protection status	Eventual threats	Touristic infrastructure	Conditions of visit	Access road	Enhancement installation
Doleritic sill of Ouzoud	**	***	**	****	****	Absent
Ouzoud waterfalls	****	***	****	****	****	Present
Ouzoud travertines	***	**	****	***	***	Absent
Estuary of Oued Tissakht (Ouzoud caves)	***	**	**	**	**	Absent
Oued El Abid Gorges	**	**	**	**	**	Absent
Chocolate marl intruded by Tanaghmelt sill	**	**	**	***	***	Absent
Basaltic flows of Ouzoud	**	****	**	***	***	Absent
Karstic spring of Ouzoud	***	***	***	***	***	Present

RESULTS AND DISCUSSION

A tourist circuit is proposed, starting with site 1 (Ouzoud dolerite sills) and passing respectively through sites 2, 3, 4, 5, 6, 7 to arrive at site 8 (Karstic springs of Ouzoud)



CONCLUSION

- The results showed that the study area is dominated by geosites of high scientific and additional value suitable for scientific, tourist, and educational use;
- Geotourism and geoeducation are vital tools that could be essential in protecting and enhancing national heritage;
- The development of regional geotourism requires good management and the best decisions to attract more visitors while ensuring the sustainability and conservation of the interest sites;
- Geoeducation aims to disseminate geosciences to the public to conserve geodiversity and ensure its sustainability for future generations.

Recommandations

- Footpaths should be established to cover all sites in the syncline in order to reduce tourist concentration around the waterfalls and springs of Ouzoud;
- Installation of interpretive panels that explain the potential of this area as a tourist and geoeducational destination;
- The tourist infrastructure and offer should also be improved to attract different categories of tourists.


Thank you for your attention!