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THE CONCEPT OF "*HYBRID RESEARCH*" APPLIED TO THE GEOHERITAGE OF THE BAUGES MASSIF (FRENCH ALPS): WHEN THE PROMOTION OF THE GEOHERITAGE HELPS GEOSCIENCES AND VICE VERSA

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Abstract: This paper presents the concept of "*hybrid research*". This concept was created to indicate, here in the field of geosciences, actions of research which serve at the same time to increase the fundamental knowledge and the applications in term of management and promotion of the geoheritage. The "*hybrid research*" requires specific tools and field experiments, which we call "*monitors*", being of use at once the observation and the measure of the phenomena and their visualization to educational and geotourism purposes. Two of these tools are presented: the GeoVision monitoring system and the participative multifunctional dye tracing. These two tools were conceived and experimented in the Bauges subalpine massif, Regional Nature Park candidate to become a Geopark.

Key words: hybrid research, geoheritage, geotourism, geoeducation, monitors, Bauges, French Alps

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INTRODUCTION

The works on the promotion of geoheritage were considered for a long time as minor and secondary towards the major subjects of research in geosciences. The current development of the topic of geoheritage, in answer to a significant social demand, requires the establishment of a specific and recognized research. In this purpose, we propose the concept of "*hybrid research*" that will be explained in this paper.

This new concept results in new tools and methodologies, which we call "*monitors*". Such tools are in the course of experiment in the Regional Nature Park of the

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Bauges Massif (French Subalps) which is candidate to joign the European Geopark Network. Two examples of "*monitors*" experimented in the Bauges Massif are presented here: the "*GeoVision*" monitoring system and the "*Participative Multifunctional Dye-Tracing*".

THE CONCEPT OF „*HYBRID RESEARCH*"

The promotion of the geoheritage in an educational and tourist purpose requires today specific tools, methodologies and processes. Their conception involves geoscientific researchers. The demand so increases that it can mobilize researchers' jobs full-time. But in some countries and particularly in France, these topics are not really supported by the academic establishment, in comparison with the aura which enjoys the fundamental research on the big subjects of geosciences as well as geosciences applied to the mining and oil search.

To by-pass this difficulty which slows down the development and the structuring of a specific search around geoheritage, we think that it is possible and advantageous to reconcile geoscientific fundamental research and applied research in the promotion of geoheritage, both feeding mutually and being able to then benefit from a common financing.

That is the creed of the concept of "*hybrid research*", serving and associating at the same time the expectations of the fundamental geosciences and those of the promoters of the geotourism and the geoeducation (figure 1).

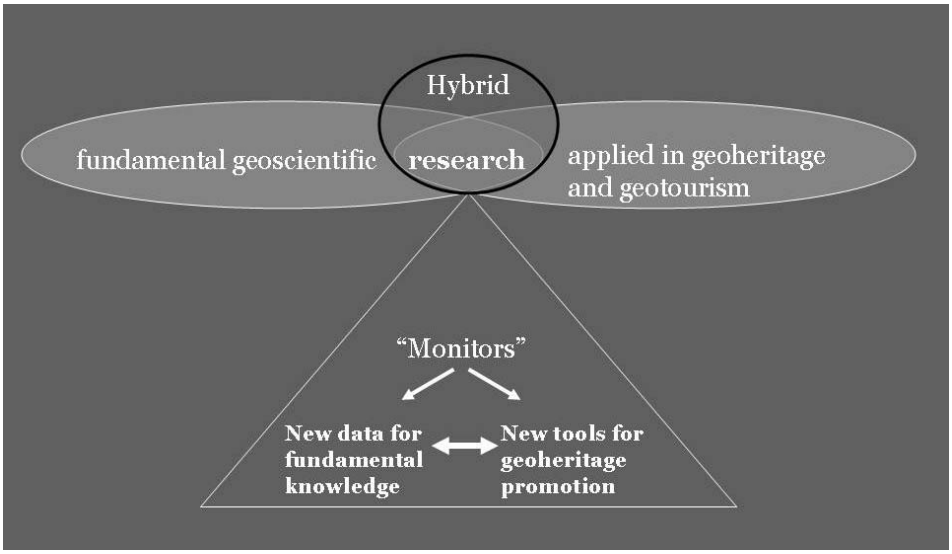

Figure 1. The concept of "*Hybrid Research*"and its specific tools ("*Monitors*")
(Source: F. Hoblea, Edytem)

As we can see on the figure 1, the hybrid research is based on a new type of tools, called monitors. These tools are also hybrid, e.g. they allow to catch data and measurements that serve the fundamental knowledge of the phenomenon observed (metrological function) and they also allow in the same time to show or explain to the public the natural event happening and the functionning of the geo or hydrosystem.

One of the main advantage of this approach is that the collected scientific data and the results obtained from the field experiments or sample analyses are very often directly useful to answer the questioning of the public. And the experiments or the visualization of the natural events are rather spectacular to catch and hold its attention.

This new kind of tools is now experimented in french prealpine and subalpine massifs which are engaged in an application to became geoparks as the Chablais and the Bauges massifs, or in nature parks which want to protect and promote their geoheritage and natural resources through actions of participative science, as the Chartreuse Massif (figure 2).

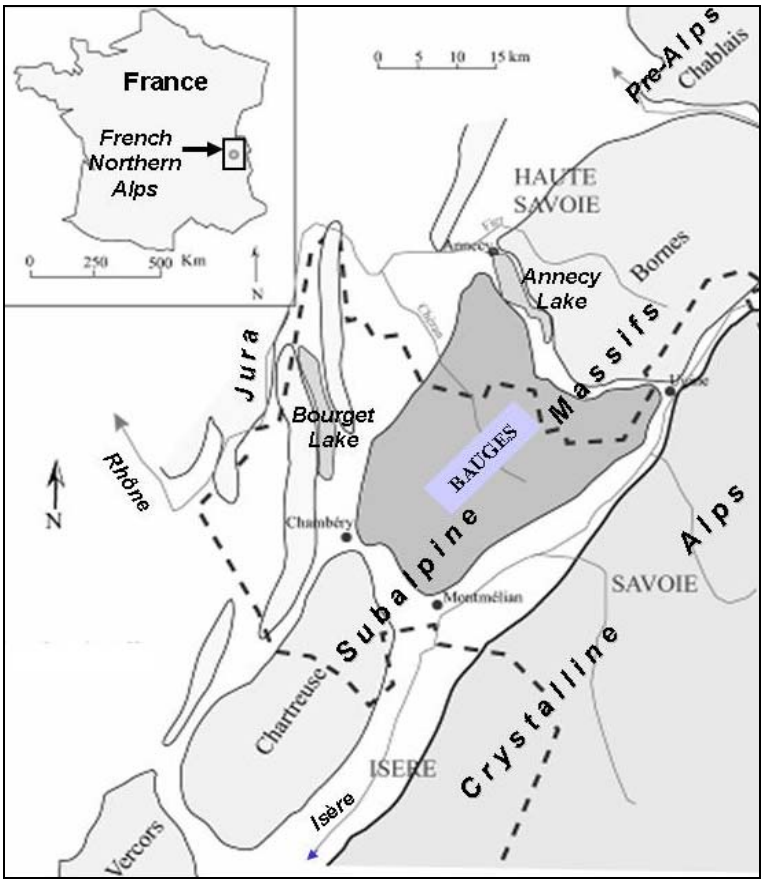

Figure 2. Location of the Bauges massif and other massifs quoted in the text

These massifs are characterized by folded and karstic reliefs in mesozoïc sedimentary rocks with numerous thick layers of limestones (especially Tithonian and Urgonian). We present two examples of monitors developped in the Bauges Massif since 2010 in the frame of an application to join the European Geopark Network.

TWO EXAMPLES OF *„MONITORS"*

The word *„monitor"* was chosen to indicate tools answering the definition of the hybrid research. This choice was guided by the fact that these tools have to assure at once a function of *„monitoring"* or collection of data, and a function of visualization just like a *„monitor"* (in the sense of monitor screen), and also an educational function, as an instructor (*„moniteur"* in French). This term is particularly indicated to appoint the GeoVision project.

GeoVision: the Nature movie. GeoVision consists in developing a station of measure and visualization of the processes relative to the extern geodynamics. The aim is to increase the knowledge of these phenomena while making them visible to the general

public, within the framework of territories concerned by geotourism and environment education. This station is a development of the process Hymage-TIP: an optical sensor connected with a treatment of images specific software, initially finalized for hydrometric applications (Fourquet, 2005; Fourquet et al., 2010). A prototype of station GeoVision is in development for the measure and the visualization of the phenomena of the Prerouge Spring floods, one of the main karstic springs of the Bauges massif (figure 3).

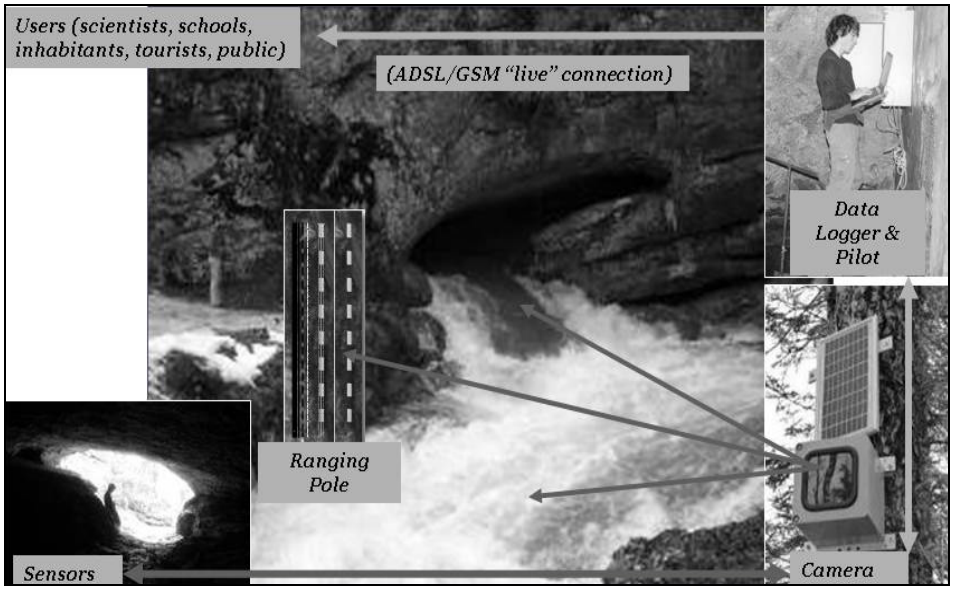

Figure 3. GeoVision: Prototype of Prerouge Cave (Bauges Massif RNP)
(Source: Denimal, 2010 / Edytem-CNRS-University of Savoie)

Movement sensors linked with the camera will also allow to count and identify the visitors of the cave which is an easy caving site, but dangerous because of the sudden floods than can occur. Equipped with water level sensor inside the cave, the GeoVision station can also serve the prevention of the risk of flooding.

It is so a multifunctional tool, serving geoscientific knowledge, geoheritage promotion, geotourism study and risk assessment and prevention. This multifunctionality is another characteristic that defines "*Monitors*", as we can also see it with the second example.

The Participative Multifunctional Dye Tracing

A dye tracing is an experiment of coloring of an underground flow of water since the infiltration area to know the release of this flow and bound the catchment area. This type of experiment is used for a long time for the knowledge of the karstic aquifers, as well as to determine their vulnerability to the pollution. It is generally realized by scientists and professionnals of the management of the water resource. The results are going to guide measures of protection and management of the resource, which impose upon the users of the water as well as upon the activities considered dangerous for the integrity of the resource. These measures are often badly accepted and misunderstood, in particular because the public is not aware of impacts of its practices and activities on the water quality of the fresh water. Such conflictual situations exist in the Bauges massif, where the dairy breeding and the forestry are major economic and identital activities, where it is until now difficult to have a reasoned practice concerning the water resource. At the same time, the massif being engaged in a Geopark initiative (Peisser and Renau, 2010), it can be interesting to develop an educational application of the hydrogeological dye-tracing, in

particular within the framework of courses of study integrating the presentation of the karstic phenomena and the sustainable management of water resources. Of these reports was born the concept of Participative Multifunctional Dye Tracing (PMDT, figure 4).

As its name indicates it, it is about an operation of participative science (Couvet et al., 2008), e.g. involving in its realization diverse types of public not specialists, but supervised. This monitor is intended at once to:

-know and become known the structure and the functioning of the karstic aquifers;

-bring information to the local elected authorities and the water resource managers to bound the perimeters of protection of the drinking water catchments;

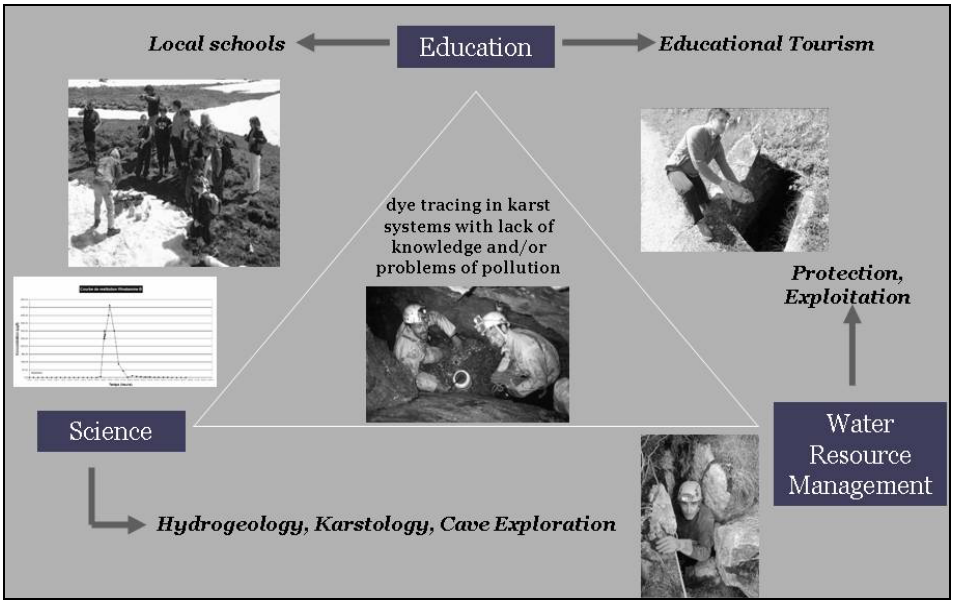

Figure 4. The concept of Participative Multifunctional Dye Tracing (PMDT)
(Source: Edytem-CNRS-University of Savoie)

-inform different types of public (local, pupils, farmers, etc.) and make them become aware of the vulnerability of their resource and of the possible impacts of their practices;

-make accept protective measures by a dialogue and a co-construction of these measures with all the concerned actors, on the basis of the results of the dye tracing experiment in which these actors will have participated.

The first experiment of PMDT took place in June 2010 in a karstic mountain of the Bauges massif heart, in association with the cavers and the pupils of the local middle school, within the framework of their courses of Earth sciences and environment education. The pupils were able to participate actively in the experiment and to realize in which point their springs were vulnerable, especially those which are fresh water catchments. Around the pupils, the operation mobilized cavers, students of the university, mountain guides, teachers of diverse disciplines in a real collective project. The managers of the resource also followed this experiment which brought them elements of information to try to resolve a problem of chronic pollution of a catched spring, incriminating a chalet of mountain pasture. The operation was a frank success and it was decided to renew it annually there where it will be needed in the massif.

The second PMDT experiment will take place in mid-May on 2011 in the north border of the territory, with important intermunicipal stakes: the grounds of the

infiltration area of the concerned aquifers are situated on a municipality whereas the springs are catched by another municipality. A part of waters could also feed directly the Annecy Lake by a sub-lakeside spring. Even there the pupils will be in the front line. They indeed represent effective mediators to make messages pass towards the adults and their awareness offers the perspective of a more virtuous behavior when they same will be grown-up.

CONCLUSION

„*Hybrid research*" and its specific tools and experiments of type "*monitors*" should allow reconciling the expectations of the fundamental research and those of the applied research in the promotion of the geoheritage. Therefore we assume that with such an approach, fundamental and applied geosciences, far from competing, support each other and strengthen mutually, in particular as regards the financing, who can combine funds intended for the institutional research and those stemming from projects for territorial development. Hybrid research and monitors are particularly suitable for territories engaged in a Geopark initiative (Peisser and Renau, 2010). In the end we hope this kind of approach will tend to be more recognized as a substantial topic of research and a full outlet for the today geosciences.

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