



The Protection Law and the Register of erratic Blocks in Piedmont (Italy), as Example of Protection of a widespread Geosite in a densely populated Region

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Abstract— The erratic boulders are recognizable and characteristic elements of the glacial landscapes. In Italy, the erratic blocks represent landmarks, centres of magical rituals, monuments, supports of religious symbols. The boulders were protected from 1922 to 1977, but today are threatened by the progressive expansion of built-up areas. Since 2010, in Piedmont a Regional Law protects the erratic blocks of high value by landscape, sport and culture. In Piedmont there are many thousands of boulders, and then not even imaginable effective protection for all rocks. Moreover a boulder of the recent moraines of high mountain has a vastly different from an erratic boulder isolated on the Plains. Therefore, the Regione Piemonte has demanded how to identify the security policy of the boulders, and list the boulders to be protected. We have begun the work by separating the erratic blocks from the other large boulders that are common in the Alps: those derived from rockfalls, or weathering (tor). Next, we divided the blocks depending on the type of value that characterizes them: environmental, historical, etc. Then we compiled a ranking of the value of the boulders for each category. Finally, we have selected for each category more boulders, giving priority to those which, for the most densely populated areas, were more threatened with destruction. So, we have excluded many boulders found in national parks, already protected by law of protected areas. The boulders that have been proposed for protection have been described in detail, highlighting what characteristics make them fit into the security law: the magnificence, if the block is enormous or dominates the local landscape; the geological importance, especially if the boulder is the last testimony of a moraine completely eroded, or allows you to reconstruct the ancient path of the glacier; man's carvings, which may be signs of quarrymen of the 18th and 19th centuries, or it may be oldest carvings; the climbing on boulders; the use of the block as a landmark; the presence of myths, traditions, historical events or legends associated with a boulder. The boulders of Piedmont, geosites from all points of view, have little geological importance in comparison to sportive and cultural value. The number of citations in bibliography and web confirms that most of the boulders are known for climbing or cultural heritage, and only secondarily for its geological interest. This confirms the importance of protect geosites also by means the sport and cultural values.

Keywords;Geosites; erratic blocks; geomorphology; cultural heritage; Piedmont;

I. THE ERRATIC BOULDERS OF PIEDMONT AND THEIR PROTECTION

The erratic boulders are recognizable and characteristic elements of the glacial landscapes. In the Pleistocene, the alpine glaciers have carried huge blocks as far as Po Plain. Many blocks are in lonely positions, and their surfaces show a strange morphology that has been attracting the attention of all men. The erratic blocks can represent: landmarks, centres of magical rituals, supports of religious symbols [1]. Moreover, the scientific dispute on their origin determined the birth of the geomorphology in the XVIII-XIX centuries [2]. Therefore, the Royal Decree 778/1922 has prohibited of destroy erratic blocks, that once were threatened by quarrymen. The law has successfully protected the surviving rocks. But today, since the law has lapsed (1977), the progressive urbanization of moraines is threatening the blocks seriously. Several boulders have been destroyed, and many are losing their fascination: they are by now in the outskirts of towns. Since a long time, the environmental organizations have been trying to promote new laws for the protection of the blocks, and of surrounding landscape.

However, from 1922 to today has become much more difficult to protect a "widespread geological site" like boulders. Surely, it is not enough, to restore the old law. The boulders are no longer threatened by the quarrymen, because today it is cheaper extract the stone from the Alps. The real danger of destruction of the boulders is today the expansion of cities, industrial areas and roads. The boulders, considered unnecessary obstacles to progress, are destroyed or buried by new buildings [3].

Since 1997, at the University of Turin, we have studied the methods for a sustainable enhancement of the boulders, within the research programs: "Tourism enhancement of physical space as a means of environmental protection" (2000), "Climate and geomorphologic risk in tourist areas" (2002), Analysis of the patrimony of landscape and its touristic use in North-West of Italy: quality, limitations, risks (2004), and "Methods of geomorphologic risk analysis in environmental protection areas and outdoor sports areas" (2006). These studies have produced a great number of data, such as the

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complete list of the still existing blocks in morainic amphitheatre of Rivoli – Avigliana along with the origin of their superficial morphologies, their cultural value (myths, landmarks...), etc. Many of these data are visible on the website of the University of Turin.

At the same time, several environmental groups, like the Association for the preservation of the Morainic Hill and Pro Natura, have acted to obtain protection of boulders of the morainic amphitheatre of Rivoli-Avigliana. This action succeeded, in 2007, when in the Regional Council of Piedmont was presented the protection law (bipartisan) 485/2007.

Unfortunately, in 2009 the deadline of term of the Regional Council of Piedmont stopped the procedure for the approval of the law proposal.

During a workshop on the presentation of the protection law 485/2007, collaboration between Department of Earth Sciences and Pro Natura Torino is begun. During the procedure for the approval of the law proposal, the “Sentinelle di Pietra” (Stone Guardians) exhibition was organized, in order to promote the awareness of value of the erratic blocks and their need for protection. Several objects and audiovisual aids were exposed, from 31 March to 29 August 2010, in the Natural Sciences Regional Museum of Turin. They showed the value natural, historical, archaeological, sportive of both erratic blocks and landscape between Rivoli and Avigliana. Collateral events also were organized during the exhibition: 4 workshops, 4 shows, 7 trips and sport events [4].

The exhibition and the events have meaningfully contributed in order to enhancing the public perception of erratic blocks value. Shortly after the end of the exhibition, the new Regional Council has converted the new law proposal 6/2010 "Protection of the erratic blocks of the Amphitheater of Morainic Rivoli-Avigliana that have high natural and historical value", in Regional Law (LR 23/2010) [5]. The law has incorporated the comments on the law proposal 6/2010 of the Earth Department of University of Turin, in particular by including the bouldering between motivations for protection of boulders. The law extends the protection to whole Piedmont, while the proposal law 485/2007 was limited to the morainic amphitheatre of Rivoli-Avigliana.

II. THE BOULDERS REGISTER

The implementation of the LR 23/2010 was started, of course, with the exact definition of the protection object. The law specifically protects the erratic boulders: so it's necessary to reject any type of block, also enormous or interesting, which was not transported by glaciers. The law besides does not protect all boulders, but only those who have at least one of the following characteristics:

- major component of landscape, environmental value, especially if the block is into a town, or if it's majestic [complies with article 2 – subparagraph (a) and (d) of the LR 23/2010];
- surfaces carved or cupels, complies with subparagraph (b);
- landmark, complies with subparagraph (c);

- cultural heritage valuable (architectural, historical, mythological, folk, complies with subparagraph (e);
- traces of quarrying, complies with subparagraph (f);
- geomorphologic or geological interest, complies with subparagraph (g);
- site of bouldering, i.e. the block has short routes of climbing (popular sport in Piedmont), complies with subparagraph (h).

For the identification of boulders falling within the law, the Landscape Department of the Piedmont Region has signed an agreement with the Earth Department of University of Turin for the realization of a register of boulders, which we completed in September 2012. We have started this work by separating the erratic boulders from the other large blocks of the Alps, e.g. the boulders of rockfalls (not fallen on the glaciers), and tor. Subsequently, we have divided the boulders depending on the type of value that characterizes them: environmental, historical, etc. Then we compiled a ranking of the value of the boulders for each category. Finally, we have selected the most important blocks for each category, preferring those who, being in densely populated areas, were more threatened with destruction. E.g., most of the rocks that are found in national parks have been excluded by register, because the parks regulation already protects these boulders.

We have filed the most deserving protection blocks individually or, in the case of bouldering areas, in groups. Eventually, the registry includes 622 between individual boulders and groups (bouldering areas), divided for valleys in the Alps, and for morainic amphitheatres in the Po Plain.

The purpose of the register is to provide a quick-reference documentation, useful to choose the boulders and prepare practices of definition of the protection area and of the constraints.

The register reports the following data, in cards divided for valleys or morainic amphitheatres (tab. I).

- Geographical coordinates and altitude above sea level (WGS84 datum).

TABLE I. FIELDS OF CARDS.

Identification	Geologic features	Values	Other features
Number card	Geomorphologic context	Landscape	Visibility
Name boulder	Lithology	Petroglyphs	Location in environmental protected area
Municipality	Discontinuities spacing	Landmark use	Location in landscape protected area
Location	Probable age	Monumental	Threats
Coordinates		Cultural heritage	Web sites of reference
		Quarrying traces	Bibliography
		Geomorphologic	
		Bouldering	

- Lithology and, when there is sure, name of tectonic unit or formation from which the boulder came from.
- Discontinuities spacing.
- Probable age of deposition of the boulder (the rock age is obviously much older), according to age of the moraines commonly accepted in the scientific community, and the geomorphologic position for the Alps valleys.
- The landscape value (fig. 1) must be stated by the competent regional department. Therefore, the card show useful parameters for evaluating the magnificence of block: visibility (at less than 50 or 200 meters, or only by footpaths and municipal roads, or by A and B roads), possible inclusion in a town, or association with a characteristic component of the landscape (e.g. basis of fortification, votive pillar, etc.).
- The card omits the archaeological importance and age of the petroglyphs, because these questions haven't found unanimous solutions. The card shows simply lack or, in case of presence, type of carvings (e.g. crosses, cupels ...) classified according to [6]. For this work we had to distinguish the actual petroglyphs from either weathering forms or recent carvings, both reported by some amateur archaeologists as old man-made carvings. The card warns explicitly when the searches haven't neither confirmed nor ruled out the man-made (e.g., pits that could be cupels).
- The card show, when the block is a landmark, both the boundary type and the symbols carved on the rock.
- The card always show both the maximum height on the campaign plane and the volume, useful to recognize the majestic but short boulders (tab. II).
- All the boulders have a significant geomorphologic value, but some have a higher-than-normal value: e.g. a particular mineralogical composition makes it possible to recognize the area of origin of the boulder, and then reconstruct the glacier's path; a reddish, thick rind is important indicator of weathering during warm arid climate; a boulder located out of moraines indicates that in the past, at the point where is the boulder, came a glacier, and the moraine was destroyed by erosion. Finally some boulders are, to Italian law, geosites, areas where their presence is of significant geological interest and didactic (fig. 2).
- The card assigns the IPTS (index of Tourist and Sports Potentiality [7]) to each boulder used for climbing. The IPTS is the sum of the scores of various quality parameters: average time of approach, hazard of lethal falls in the absence of belaying or self-protection on a fixed rope, goodness of landing on the crash pad, possibility of protecting climb with a rope, climbing routes amount, variety of styles of climbing, suitability to different types of climbers (beginners, experts, etc.). The boulders with $IPTS \leq 5$ have little value; those with IPTS from 6 to 9 are good for the bouldering or exploitable well, those with 10 to 15 by IPTS (maximum value) are of high quality. When the climbing is impossible or stupid (boulders that are included in monuments, too low ...) the IPTS is 0. The card describes in detail the factors that determine the IPTS, in addition to the lines of ascent and the category of climbers (beginners, professionals ...).

TABLE II. MAXIMUM HEIGHT (H) AND VOLUME (V) OF BLOCKS, AND CORRESPONDING SYMBOLS.

Volume (V)	Height (H)		
	$H < 4 m$	$4 m < H < 10 m$	$H > 10 m$
$V < 30 m^3$	AA (typical small erratic boulder)	BA (middle, menhir-shaped)	CA (unnatural)
$30 m^3 < V < 3.000 m^3$	AB (or boulder sunk in the ground or slab lying on the floor)	BB (typical middle erratic boulder)	CB (tall, big menhir-shaped)
$V > 3.000 m^3$	AC (this is theoretically possible, but it's not recognizable without geological survey)	BC (boulder quite sunken into the ground)	CC (typical huge erratic boulder)

- The card warns if the boulder has cultural value, and what kind is this: architectural value (when a construction contains the boulder or stands on it), historical, mythological (when the myths relate directly to the boulder), folkloric (when the rock plays a role in folk traditions).
- The card reports the presence and type of quarrying's traces, such as holes for insertion either of explosive, or of wooden wedges.

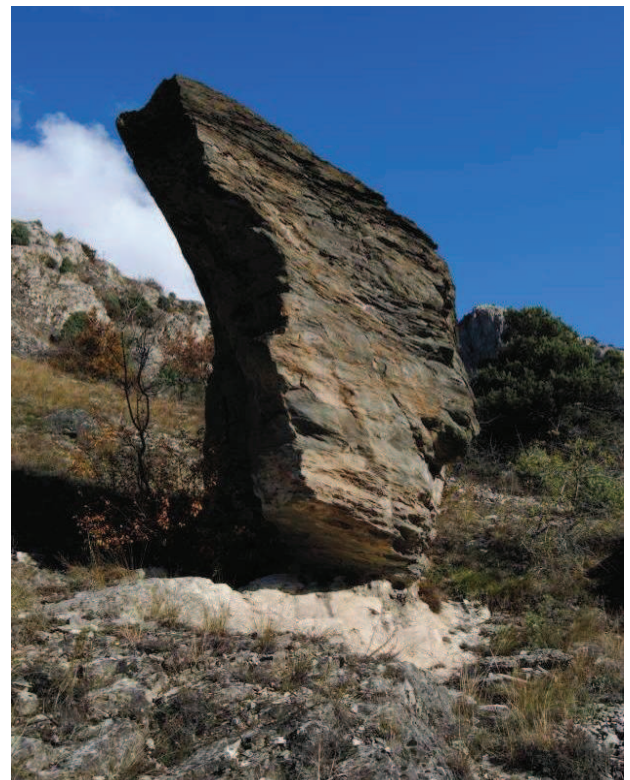


Figure 1. Pera Aguà (Susa Valley) is a block that has great landscape value, but little geologic value.



Figure 2. The value of Masso Spaccato (Pellice Valley) is both landscaping and geomorphologic.

- The card does not show the owner of the boulder, which is unrecognizable systematically. The card shows only if the access is allowed in 2012 year, and the visibility of boulders, if they are fenced, from the edge of the enclosure.
- Where there is a formal ban on damaging the environment (including boulders), the card indicates the name of the protected area.
- When the block is in a landscape protection area, the card indicates the reference article of regional law. In Piedmont, in addition to the areas identified by art.136-157 of law D.M. 8/1/1985, are generally subjected to constraint the soils above 1600 m a.s.l. (art. 142d), at less than 300 m from the lakes (section 142b) or 150 m from rivers (art. 142c), woods (art. 142 g), and the national and regional parks (art. 142f).
- In presence of high threats to survival of the boulder, the card describes the kind of threat: progressive inclusion in built-up area, possible extension of the nearby roadway, proximity to industrial area; proximity to active quarry, hydrological hazards and threat by any hydraulic works.
- The card lists the web addresses where the boulder is mentioned, which were controlled and consulted in 2011, and the references.

Normally the following attachments accompany the card:

- photo-mosaic from Google Earth with the position of the boulder.
- geo File in .kmz extension to place the block on Google Earth, GIS or GPS.
- digital photographs of the boulder.
- scheme of any climbing routes.
- map of possible protection zone (for bouldering area with several blocks).

- historical photos of the boulder, if of interest.

III. THE CHARACTERISTICS OF THE BOULDERS PROPOSED FOR PROTECTION

We have considered both the number of listed boulders and the number of their citations (books and websites; fig. 3).

The boulders piled most commonly are bouldering sites (34%), and a bit less geomorphologic sites (18%) or landscape valuable elements (18%); the blocks of cultural importance (10%), monumental (9%) or carved with petroglyphs (8%) are less numerous, but not uncommon. The ones that are drilled for quarrying (2%) or used as a landmark (1%) are very few. If we classify the values depending on the number of citations in the bibliography and web sites, stands out even more the sporty vocation of the boulders (51% of citations), followed by (22%) geomorphologic one.

A single boulder may have different values simultaneously. This overlap can be evaluated by comparing the percentage of the number of blocks with multiple values, with the total number of boulders of a given value (tab. III).

The boulders of cultural significance (46%) are the major elements of the local landscape: so, the man has interwoven stories and legends about the main visible rocks of its territory.

The monumental boulders are loved by climbers: a 66% of this type of rocks is interesting from their point of view.

The man has carved petroglyphs just in the 3% of monumental boulders, and in the 1% only of boulders that are difficult to climb (and therefore of high value for a climber). Most of the boulders with petroglyphs are far removed from the streets; many carved boulders are attached to other elements of the landscape (fig. 4).

The monumental blocks are always large, whatever is their form (fig. 5), and, of course, they are most commonly in a dominant landscape position so as to be visible from nearby roads.

To engrave the petroglyphs are more interesting the rocks with easily accessible summit: so this kind of boulders is always small or medium-sized.

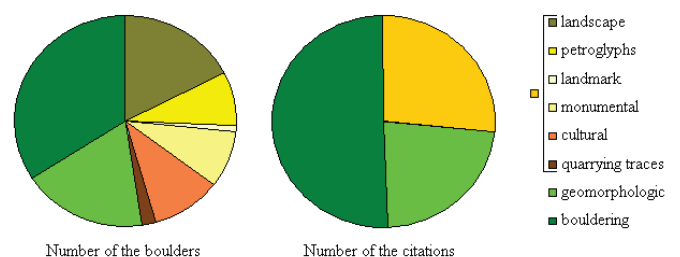


Figure 3. Number of the boulders and the citations, for kind of value.

TABLE III. COMMON VALUES IN RELATION TO THE TOTAL NUMBER OF EACH VALUE

Percentage (%)	Value							
	landscape	petroglyphs	landmark	monumental	cultural heritage	quarrying traces	geomorphologic	bouldering
landscape	100	13	2	19	27	4	40	35
petroglyphs	26	100	3	3	24	3	9	1
landmark	33	33	100	22	44	33	0	22
monumental	39	3	2	100	31	3	19	66
cultural heritage	46	20	4	26	100	8	26	25
quarrying traces	42	16	16	16	42	100	21	37
geomorphologic	38	4	0	9	15	2	100	57
bouldering	18	0	1	17	7	2	30	100

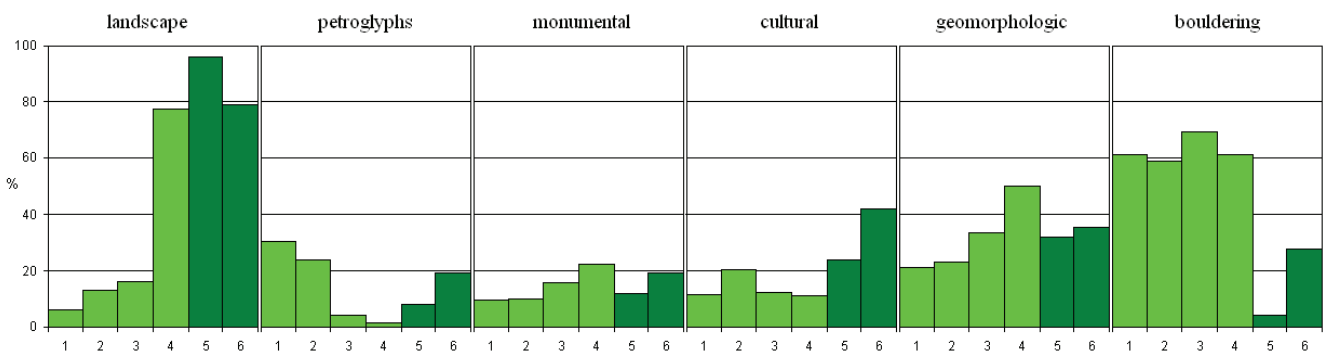


Figure 4. Distribution of boulder visibility for each kind of value (1: immersed in the vegetation. 2: visible at a distance of 50-200 m from paths or roads. 3: visible to more than 200 m. 4: visible from A and B roads. 5: posted in town. 6: associated with characteristic feature of the landscape).

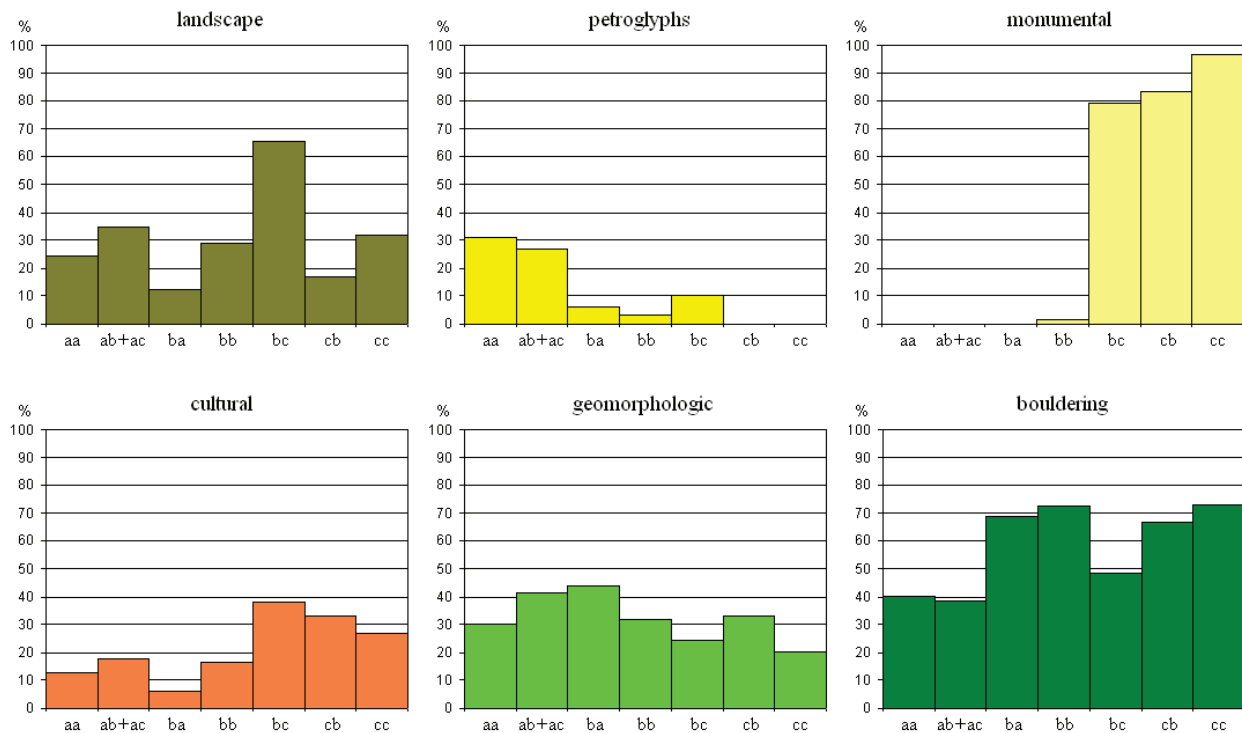


Figure 5. Distribution of boulder sizes for each kind of value.

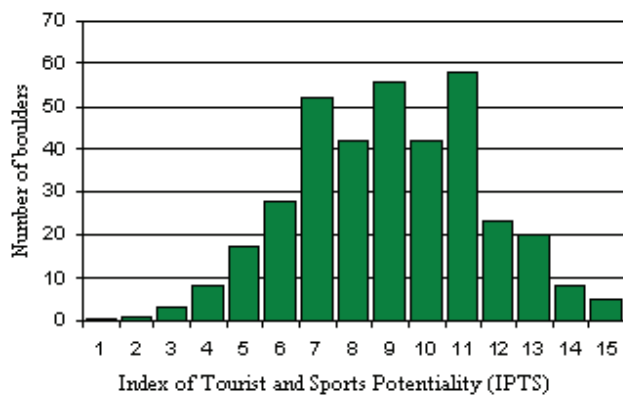


Figure 6. Statistical distribution of the IPTS, for the climbed boulders.



Figure 7. The Coppellato di San Grato Boulder has great religious value since ancient times, as evidenced by the 274 cupels and the votive pillar dedicated to St. Gratus.

Climbers generally prefer spherical boulders, well detectable and easily accessible, and dislike the smaller boulders, those in urban contexts and those associated with other elements of the landscape (however the last two types of boulders are always specifically protected by law).

The statistical distribution of IPTS index [7] presents bell shape, with an average value around 9 (fig. 6). Generally, the boulders that have low IPTS have not bouldering as prevailing interest, but they are climbed, and they can be very popular, if are close to many other climbable boulders,

forming together a bouldering area. Most blocks of landscape value, cultural or geomorphologic interest, do not are huge or with a characteristic shape. The importance of the landscape value is, of course, greater to the boulders located along important roads and especially for those placed in urban contexts or bound to other elements of the landscape. Most blocks with geologic interest are once again those within easy reach. The boulders of cultural significance are often located either in urban contexts, or in positions rather secluded and not very visible.

IV. CONCLUSIONS

The boulders show a geological importance secondary to that for the climbing. The number of citations (bibliography and web) of different kinds of blocks confirms that most boulders is mainly known for bouldering or the cultural heritage, and only secondarily for its geological interest.

This confirms the importance of protect geosites, also exploiting elements of no geological interest (e.g. sports, myths, beauty, etc.). The geologists should not just explain scientific aspects of erratic boulders, but should show their link with myths or folk traditions, without ridiculing them, and preserving their fascination. In other words, the strictly geological aspects of the erratic boulders are the meeting point of manifold cultural aspects. Under these conditions, this kind of geosites will appear notable and worthy of protection at all people.

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