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The impressive Trygław – Poland's largest glacial erratic boulder, situated in Tychowo, in the cemetery of the town of Białogard in Poland's central Pomerania region, classified as a national geological monument. Gneiss, volume 860 m^3

ERRATIC DISAPPEARANCES

They are a vital source of information about the glaciations that covered significant areas of Poland in the Pleistocene. They intrigue not only scientists, but also geotourists. So why do glacial erratics so frequently end up vandalized?

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The glacial erratic boulders found in northwestern Poland (and northeastern Germany) are portions of rock material that were once carried by the Scandinavian ice sheets and deposited in a different geological environment. Their name derives from the Latin *erro*, 'to err, to wander, to rove, to go astray.' To be classified as a glacial erratic, such a rock must measure at least 0.5 m along its shortest axis.

The Scandinavian erratics represent all the petrographic types of rocks: igneous, metamorphic, and sedimentary. This tells us that the ice sheet moved forward, scouring and 'plucking' outcrops of Proterozoic rocks of the southern portion of the Baltic Shield as well as the Neoproterozoic, Lower Paleozoic and Upper Mesozoic rocks of the Eastern European Platform, which occur in today's Sweden, Finland, and Baltic Sea floor. However, igneous and metamorphic rocks are by far the most prevalent, due to their greater durability.

About 10% of the entire population of Scandinavian erratics are known to originate from a single specific source area in Scandinavia, and so they are classified as absolute indicator erratics. These rock types include Bredvad porphyry, Karlshamn granite, and Kalmar sandstone. A further 30–40% of the erratic boulders brought in by the Scandinavian ice sheet are classified as statistical erratics, as their rock types can be traced back to a larger number of potential source areas, or to a source area of larger size. Their names therefore do not refer to a specific location, but to their chronostratigraphic age: e.g. Jotnian sandstone, Lower Paleozoic limestone, Devonian dolomite, etc. The remainder of the Scandinavian erratics are predominantly igneous and metamorphic rocks that can only be said to derive from a source somewhere in the Baltic Shield.

Unprotected by law

Glacial erratic boulders of large size generally occur *in situ*, in other words in the very location where they were once "dropped" by the ice sheet. Their massive size is the main reason for this, but not the only one. This group includes all the large glacial erratics in Poland that are under protection as natural monuments. These include Trygław in Tychowo in central Pomerania (the largest glacial erratic in the country – gneiss), the rock in Kowiesy near Mszczonów in central Poland (the largest sedimentary erratic in the country – sandstone), and St. Jadwiga's Rock near Gołuchów (the largest erratic in the Wielkopolska region – Småland granite). The Nature Protection Act of 2004, however, does not contain any provision clearly stipulating the criteria based on which glacial erratic

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boulders should be protected (their size, petrographic type, significance for cultural heritage, etc.). Protection regulations in Germany, on the other hand, apply very specifically to igneous erratics with a minimum volume of 10 m^3 in the Pomeranian stage (longest axis ≥ 3.5 m), 5 m^3 in the region between the Pomeranian and Poznanian stages (longest axis ≥ 2.5 m), and 1 m^3 to the south of the Poznanian phase (longest axis ≥ 1.5 m), as well as to all sedimentary erratics irrespective of size (due to their lower resistance to physical and chemical weathering).

Because the Polish regulations fail to provide such clear stipulations, glacial erratics here are increasingly subject to vandalism. The interesting structure and texture (size, shape) of the rock crystals, and often their color, frequently cause them to disappear from the landscape. They offer ideal stone-working material to sell to both individual customers (e.g. as gravestones, window sills, countertops, floors) and for large-scale investments (building façades, the interiors of major company headquarters or for instance Warsaw Metro stations). Their disappearance deals a blow to the given area's geodiversity, a gauge of the richness of its geological, geomorphological and geographic heritage. This, in turn, entails a drop in its attractiveness for geotourism, which obviously has an impact on the local policy of sustainable socioeconomic growth. Effective popularization of the geological heritage by local guides or interpreters of nature, in the form of workshops, eco-museums, geocaching/quests and the opening up of such sites to public access (provided that proper safety measures are taken) can definitely bring financial benefits directly to the local residents, and indirectly to the local governments of the areas where they are situated.

Halting the devastation

Striving to curb or at least minimize the losses caused by such vandalization, petrographic gardens known as "lapidariums" (from Latin *lapidarius* – 'stone') can be established. Here boulders are gathered in one place, preserved and exhibited *ex situ*. Such collections in Poland include the Stone Garden in Moryń (part of the planned transborder Oder Valley Post-Glacial Landscape Geopark), the Petrographic Garden in Złocieniec (a branch department of the Regional Environmental Protection Directorate in Szczecin), the Lapidarium of the Institute of Geology, Adam Mickiewicz University in Poznań, the Petrographic Garden of the Wielkopolska National Park in Jeziory, and the "Drawnik" Petrographic Trail at Drawa National Park. There are also some less formal ones, such as the rock collection nearby the school cluster in Kuźnica near Sokółka, and the Geological Garden that forms part of the private Elżbietówka park near Breźno in the Wielkopolska region.

But the greatest educational and scientific value, of course, lies in erratics still preserved *in situ*, as indisputable attestations to the past glacial epoch. These days they are also increasingly being viewed in terms of their educational and geotouristic functions. Every erratic boulder has a story to tell, and as such they can be useful not only to scientific researchers but also to middle-school and high-school geography teachers. They serve as excellent points of departure for geoeducation, teaching about the petrographic types of rocks, the nature and type of endogenic processes, tectonic structures, erosion, glacial transport and accumulation, and also modern-day morphogenetic processes affecting the boulder's surface since it melted out of the ice sheet. More interested individuals may want to learn more about modern methods used in dating when boulders became exposed, using cosmogenic isotopes.

Geotourism, in turn, is a sustainable way of reaching out to "alternative" tourists, whose interest is not just limited to snapping a selfie against the backdrop of a natural monument, but who are also intrigued to learn about how that monument came to be as it is today and what it can teach us. However, this demands the preparation of the appropriate information board or pamphlet, and it is also crucial for local guides to have a good awareness of the site, being able to explain its origins and value and thereby boosting appreciation of the region's geodiversity.

Developing this new branch of tourism does not require the creation of new "geoproducts" – they already exist. One thing it does require, however, is a clear stipulation in the law of which erratic rocks should be preserved for future generations, and based on which criteria. Otherwise, someday soon it could prove to be too late. ■

The Role of Glacial Erratics The Scandinavian erratic boulders have been a subject of study for decades (with varying intensity), with the main objective of reconstructing the range and history of the ice sheets, and thereby broaden our understanding of the history of the Earth's climate. Erratics can be used to identify the direction of transgression, or how the ice sheet spread. Because of the Pleistocene ice sheet's changing transgression and the varying orientation of the alimentation areas, the analysis of such boulders can also largely identify the age of the glacial deposits containing them. Moreover, in the latest research glacial erratics are used in identifying when deglaciation (ice sheet withdrawal) occurred by analyzing the content of cosmogenic isotopes such as ^{36}Cl and ^{10}Be. This reveals how long a rock's surface has been exposed to the influence of cosmic rays from space, which therefore tells us how long it has not been covered by ice.

Further reading:

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