GEOSITES—a new conservation initiative

Some geologists notice that geoconservation is a vital necessity only when a cherished key site is damaged or lost. Geoconservation is a fundamental to the prosecution of geological research, education and training but it has been the Cinderella in nature conservation, often nationally and certainly internationally. However, it is key to conservation as a whole, and geo(morpho)logical sites and terrains of outstanding global significance merit conservation, on a par with other internationally significant sites, such as those protected for wildlife or their wilderness value. Taking a holistic view, geology underpins all landscape and biotic nature, and biodiversity is frequently determined, or at least influenced strongly, by geodiversity. The geological story, time and its scale, are continuing sources of wonderment to earth scientists and lay public: the conservation of sites encourages and fosters such wonder and is a challenge we face as geologists. From that awe, and an understanding of the importance of sites and terrains in establishing the geological record, comes respect and an appreciation of the need for conservation.

In 1995, IUGS, on behalf of the international geological community, set up GEOSITES, an ambitious global scheme to promote geoconservation, focussing on the identification of globally significant sites. Past attempts at selecting geological sites for World Heritage status have faced the problem that there is no international listing of key earth science sites. IUGS initiated GEOSITES (now, also under the auspices of UNESCO) in part to address this problem, and to realise geologists' ambitions to have a representative selection of internationally significant sites and terrains included in world and regional listings, and site designations.

The GEOSITES project, under the guidance of the Global Geosites Working Group (GGWG), aims to produce an evolving, comprehensive inventory (to be held in a database, at IUGS Trondheim) of the most valuable Geosites. Such a project has potential value in education and research: it certainly has potential for promoting a greater knowledge of geology amongst a wider public, and for use in broader initiatives in geoconservation, including schemes to define international site designations. The project is particularly useful for cross-border links and collaboration.

Only geologists can compile a global geosite inventory and justify the significance of localities, a task which will certainly take some years to achieve. It requires the promotion of meetings and workshops that

examine site selection criteria, selection methods or conservation of key sites, and these tasks are already involving specialists, research groups, associations etc. Ultimately, it will be possible to advise IUGS (and UNESCO) on the priorities for conservation in the global context. Without a global inventory, and allied comparative assessments, designation of global sites would be much harder and open to criticism for not being based on an objective examination of the global picture.

GEOSITES methodology—the challenge

The Earth is 4500 million years old. How do we demonstrate and judge what is valuable in that portion of history which survives in the rock record—evidence of plate growth, migration, collision and destruction, the evolution of life, of sedimentary basins, of mountain chains, rifts and volcanic provinces? To make any sense of the complex geology of any country or region, a concerted effort is needed to discern the patterns, to define the context and to fit sites (compared and graded) into that context.

Fortunately, the same classifications of rocks and landforms, of minerals and fossils, and divisions of geological time apply worldwide, so site categorisation is fairly easy. The identification, suggestion and selection of potential sites for the international listing is the real task. The scale of this undertaking immediately requires that a systematic method be employed, including integrated inputs from national and supranational groups of contributors.

If geological and landscape history had been the same in all parts of the world, and if the environments, minerals, rocks and fossils had been of uniform distribution, then the task would have been simpler. A lesser number of sites might have sufficed to demonstrate global patterns. However, this is far from being the case. We have therefore to select a limited, but representative, set of sites, to produce a balanced coverage between countries and regions. That group of sites has to represent all, or at least many, of the truly significant processes and events, time periods, features and topics. Geology and landscapes do not respect national borders: therefore coverage of sites and terrains has to conform to regional patterns.

Any *ad hoc* method, would be unsatisfactory, for sites would be then viewed in isolation, and the result would be a fairly random product, leaving too much to chance. The same could be said about selection based on particular kinds of sites, concentrating on, say, spectacular mineral sites, or sites related to Man, or certain geological periods. It would be no simple or obvious matter to choose five or ten token sites to represent a geological period or minerals worldwide! Also, this method ignores the complexity of the rock record, and it could not give a fair coverage of localities between countries; broader patterns cannot be thus assessed, and some countries would

finish by having few or no sites in the list. What is more, all countries do not have a geological sites inventory (although GEOSITES may help with that problem), let alone some form of designation or protection of sites. Selecting a global list on the basis of pre-existing designations would therefore be difficult.

Time is, of course, the factor which separates geology from other disciplines: in putting together a global listing, it is necessary to have representation not only of processes and features, but also to exemplify these through geological time. We should avoid therefore, the temptation of selecting just a few superlative localities ignoring the time matrix, but this is not an easy task. Using the fossil record as an example, GEOSITES has already come up against the puzzle posed by major extinction events in the Phanerozoic. Nineteen large-scale events have been recorded (those with more than 50% species loss), each with varying degrees of clarity and precision. Some work is needed to decide which sites best represent an event, but first it has to be decided which events must be demonstrated.

Selecting the 'best' mineral or fossil sites, or one or two sites to demonstrate a system, say the Jurassic, sounds simple. However, is it, if one considers the notion of geo- and palaeo-biodiversity? The Jurassic, for instance, lasted over 75 million years, with broadly distinctive, but changing, fauna and flora, reflecting in part, climatic and topographic change, and fluctuating sea levels. Even such well-known Jurassic sites as Tendaguru, Durlston Bay, Solenhofen, Stonesfield or Como Bluff (all included in the GEOSITES inventory, and superlative localities!) show only a fraction of what is special or typical in that period.

Avoiding the pitfalls of *ad hoc* and subjective approaches, we are looking to use methods which have scientific rigour, producing a balanced and fair coverage between the countries.

A method based on systematic survey and comparative assessment

Having taken the first step of recognising the scale of the geological resource and the potential number of interests available, we have an indication of the potential for selection and the numbers of sites involved, based on various natural classifications of geological themes and time.

We wish to identify and document, not token examples, but those features, sites and areas which show broader patterns, which allow comparisons and correlations and give an in-depth understanding of the Earth's evolutionary story. In any balanced compilation of a regional or global inventory, certain kinds of site need to be included. These should show significant stages, the special and, especially, the representative. There is no possibility that GEOSITES could include all the vital stages of the inanimate or fossil record of every period, epoch or stage, or

region although the ambition is to encompass many of them. The superlative nature of the site will ultimately determine selection; selection being carried out in a comparative and thematic way, comparing sites' interests and their merits in a defined context or pattern (Wimbledon et al., *in press*; Zagorchev, *in press*). The use of such topic, time, and regional frameworks is vital, otherwise the enormous diversity of geological history would be beyond assessment: we would 'drown' in the detail.

Contributions

GEOSITES, in practice, relies on contributions of site suggestions from country committees, national agencies and individuals. The aim is to channel suggestions of single localities through regional working groups, each of which will endeavour to place a locality within a meaningful time, rock or other setting. Such regional groups will be able to call on the advice of other specialists, including, for instance, IUGS subcommissions.

The inevitable corollary to the broader comparative approach, taking full cognisance of geological time and diversity, is that compilation of a definitive inventory for GEOSITES, if done properly, is a large task, which will take some years to complete. There is no 'quick fix' that will allow the instantaneous definition of any kind of geological site list, let alone larger inventories, and colleagues involved in pilot schemes in Europe have estimated that there it will take at least three years work to refine criteria, to define regional frameworks and to achieve a preliminary listing.

For the outcome to have high professional standing, inputs must be invited from all with an interest in the sites. Although regional comparative assessment and validation is important, indeed the key to the process, ultimately all selections will be made by geo(morpho)logists within the countries: workers must be left to propose those sites which they judge represent the geological record of their region. Considering complementary sites, and not just the most obviously superlative ones, GEOSITES can accommodate sites or terrains ranging from those of high sub-national value, through national and regional, to those of the highest international significance.

Early application of the GEOSITES technique

In Europe, a number of national groups and individuals have already started to take up the challenge, providing a pilot project for GEOSITES in a global setting. ProGEO (the European Association for the Conservation of the Geological Heritage) is acting as an agent for IUGS in compiling a European inventory, and its regional working groups are assembling sub-European listings. As an example of the approach, Europe, as a geological entity, is being considered under its natural subdivisions—the Precambrian shield, the Caledonian orogen, the Variscide front, the Variscan massifs, the Alpine fold belts and so on. Within each tectono-geological framework element, stratigraphic, igneous or metallogenic successions or events can be considered. The aim will be to demonstrate the key features in, for instance, a tectonic setting such as the Variscan Front or a stratigraphic sequence within such a tectonic framework element, such as a Tertiary section in the Danish Triangle or volcanics in the Oslo Graben, or ice-front features from the Weichselian glaciation.

To compile regional inventories, selection will be made within regional geological contexts such as those just described, placing sites within national and regional contextual 'shells', like nested Russian dolls. In addition, specialist groups will be asked to work in parallel, contributing on particular topics, such as mineral groups of tectonic elements, within their purview. Work has already started on a draft international list of sites recording the salient features of palaeobotanical history (a first draft list was presented at the IGC in Beijing), and discussions are going on over a similar vertebrate listing. The former list will contain sites demonstrating the most important elements in the evolutionary story of plants, related to environmental and other change. It, like other specialist inputs, will be used to assist national efforts, and as an aid in documenting sites and a guide in making selections.

Conclusion

GEOSITES offers prospects for strengthening efforts in both national and international conservation settings: lending support and helping to further national, internal initiatives and giving geologists regionally a

focus for cross-border collaboration. For the first time, this gives IUGS the possibility of having a database and an organic liaison network which it can use to advise on the scientific justification for global conservation priorities.

Geologists want to see a representative coverage of geo(morpho)logical sites in the world list. GEOSITES has the potential to lead to a justified world inventory, with truly validated selections. It can help to put geoconservation 'on the map', and perhaps allow the proposal of candidates for the World Heritage List based on objective judgements.

IUGS has already contacted all national committees to acquaint them with the start of the GEOSITES project. Pilot studies for the project set up in Europe, devising and testing criteria and selection methods, have been running there for some months. Enthusiasm for the work has been expressed in many countries, and contacts have been made in most continents to make a start on setting up networks of contributors.

Anyone wishing to further the aims of IUGS, in involving geologists in regional and global geoconservation efforts, is urged to join in the work of the Global Geosites Working Group; to join one of the regional groups being set up (if in Europe, to contact ProGEO), and to take part in the proposal of geo(morpho)logical heritage sites within their own country.

References

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