

Periodic Assessment of Research, Development, Artistic and Other Creative Activities VER 2026

Final Report of the Earth Sciences Sub-panel

We provide here some comments on the quality of science we evaluated in the Earth Sciences sub-panel during VER 2026. We make some comments on areas of strengths and weaknesses in the Slovakian Earth Science community, including in the Social Impact and Creative Environment sections.

We also provide some comments on what was typical in each of the output quality levels and some observations on ways to improve future publications by Earth Scientists in Slovakia.

1. State of Earth Sciences in Slovakia from VER Assessment

Overall those of us who also took part in VER2022 observed that the general quality of the Earth Sciences outputs has subjectively increased, on average, but end-members remain, i.e. there are several low quality (unrated) national outputs and some (a few) excellent world-leading outputs. In the upper end of the quality range there were some splendid outputs that were a real pleasure to read, with excellent advances and insight plain to see.

Which fields look strong in Slovakia? We saw high quality outputs in many of the fields in which Slovakian Earth Scientists are active. So whilst we do not want to be divisive, it is worth noting some fields where we saw more consistent high quality outputs and Social Impact.

The broad fields of geology and geomorphology in geosciences are strong and competitive at international level. There were some excellent outputs on the geology and geomorphology (including past climate changes and tectonics) of the Western Carpathians. Specifically

there was a considerable body of work on the geomorphology and past glacier and climate history of the Tatras Mountains that was excellent and with significance for study of other mountain ranges.

The field of hydrology was well represented with a strong body of work and some high quality outputs, ranging from work on floods to snow/avalanches and some excellent outputs on climate impacts in this area.

There was a large body of work in geotourism and geoconservation, particularly around limestone/karst features as well as disused mines. This is a strong thread of work with clear implications for public interest in (and support for) geology. We suggest those working in this area might think about showing more clearly how this important work is relevant to other parts of the world with similar geological resources: try to move it beyond a focus on Slovakia.

Mineralogy, geochemistry and petrography were reasonably well-represented and we noted the strong practical applications evident in some of this work and the obvious industrial linkages that exist.

Notably, several outputs – in hydrology and several other sub-disciplines - have rich field data collections from long monitoring efforts; such data are valuable and we believe can be exploited even more, and there is a strong case to maintain such monitoring especially in the field of climate impacts.

We saw very few high quality outputs in social geography. The outputs in this discipline tended to be very locally focused, and were often of a descriptive or review nature rather than providing significant original contributions. Most did not make clear their originality, significance or relevance, although a small number of good outputs in this area made their significance beyond the Slovakian area of study much clearer e.g. in terms of insight into understanding other Visegrad or EU countries.

We saw relatively low amounts of work on paleontology and volcanology, despite some fairly recent volcanism in the region, and evidence that where it existed some of the palaeontological research was of a very high standard.

It is evident to the sub-panel that the Institutions are very well equipped for modern field research (sensors, labs, equipment), at very high standard, and are exploring ways to use more advanced techniques in their research, including a significant body of work that take advantage of new UAV capabilities, and airborne surveying technologies. We commend this use of appropriate technologies and urge institutions to invest sufficiently to keep pace with developments in field and analytical equipment, or to provide means of funded access to shared facilities.

We also saw evidence of some important recent collaborations to provide some multi-national datasets in e.g. seismic and other geophysical data, and we commend this sort of use of wider datasets in order to improve the rigour and significance of the research being done.

Earth Science is a collaborative field, many outputs are nationally and internationally co-authored, this is good and should be pursued vigorously in the future, also with Slovak scientists leading even more of the work necessary to develop these collaborations and publish the outcomes.

2. Recommendations

- To Institutions and individuals: although we saw an improving trajectory of Earth Sciences in Slovakia, there remain a low number of outputs in the world-class excellence range. Why? We suggest that researchers and institutions are bold in looking more into global problems and methods, and particularly to go beyond case study confirmative research in Slovakia. To be clear it is possible to undertake such world-class work studies

at Slovakian (field) sites or with Slovakian geological material, but we urge researchers to think about undertaking studies that are likely to have implications beyond Slovakia's borders.

- To Institutions: Create strategic challenges in your disciplines that integrate several working teams, and push these to get a synergetic effect. These may also be temporary directions you agree to pursue for a time period, in response to global relevance or urgency. Try to make your strategy focused on challenges rather than embedding hard-edged disciplinary groups or 'silos' that do not collaborate sufficiently.
- To individual researchers: venture more into basic theoretical and especially methodologically innovative research (more "fundamental-applied research"...). Too many outputs are applying existing approaches locally, and have a case study character.
- To individual researchers: bring your research, even if it is local, into a big picture, i.e. how it addresses the greater problems in the field, and make very clear in publications what originality you bring.
- To individual researchers: there is an inherent weakness in regional studies without context and relevance for the wider sciences. Applying an existing well-known method to a new area without fully justifying why can lead to confirmatory case study science. Try to minimize this type of research.
- To individual researchers: you have a choice where you publish, use that choice wisely, better journals mean better visibility and higher impact, and the high quality reviewing process can often improve the quality of papers. And avoid predatory journals or those with such a reputation as they will not help strengthen the science you are publishing. In other words, it is better to prefer quality over quantity.
- To individual researchers and institutions: we can see an increasing amount of international collaboration in the outputs we evaluated and in the Creative Environment statements. We commend this and indeed some of the strongest papers we saw involved

collaborative research, often in Central or Eastern Europe and integrating work in Slovakia with work in the EU and elsewhere.

- To Institutions: Increase your visibility internationally by identifying areas of strength, in which you can exercise scientific leadership, e.g. coordinate EU Projects, run large international conferences, etc.
- To institutions: We saw some outputs that were clearly very weak indeed and should have been recognised as such. When considering the institutional submission, focus on strengths more, and introduce a bit more realism about weaker outputs (don't push them as hard as the clearly strong ones). In other words, if you do not do so already: start thinking about VER early, run comprehensive mock-VER exercises within the institution, work with staff to discuss their outputs, and learn what helps improve the quality of outputs, and fine-tuning the Social Impact and Creative Environment statements with a clear eye on how these might be viewed by the sub-panel to which you submit.
- To institutions and researchers: related to our comments on being challenge-focused in the strategic thinking we urge some thinking around developing work with wider implications beyond the individual disciplines and which are likely to lead to interdisciplinary follow-up studies. Developing more continuity in the flow of outputs on addressing a particular challenge can be more effective rather than a collection of individual stand-alone outputs, especially if excessively based on individual case studies.
- Ensure that each output has a statement on how it advances science and/or makes an impact, and in specific terms (not vague generalisms). For a reader of the output, why should this matter to them? For example, is there a new geochemical methodological innovation with wider implications for this sort of geochemistry being undertaken elsewhere?; or are there results from a periglacial study that are particularly relevant to other mountain regions? Does the output include the most rigorous and comprehensive review of a topic – if so then say so and try and be clear on the implications of bringing

together such a body of work and the new insight and understanding it can bring, and suggest future research directions.

3. Comments and recommendations from evaluation of Social Impact and Creative Environment statements

- In some submissions the sub-panel had the impression that the institutions lack internal coherence and organization between units, there were few Social Impact and Creative Environment statements that had clear strategic scientific goals that are institution-wide and integrate everyone's potential contributions. We recommend to formulate short and long-term visions and challenges for Institutions. Some in fact tried to do that, and this is a good strategy.
- We recognize that the infrastructure state of the Institutions is generally very good and comparable with top institutions in Europe.
- We strongly recommend to publish PhD dissertations in English, where this is appropriate to the field, especially in sciences. This should be viewed as embedding writing in English into the training of the next generation of researchers, but also ensuring that the theses have the widest possible readership.
- Institutions that grant PhD degrees should aim to have concrete programs that provide support to PhD students, especially focused at strengthening their scientific foundations and networks, internal PhD seminars, technical skill development, summer schools, even family support (e.g. child care, flexible hours, etc.). Describe these in detail in future creative environment assessments: the PhD students coming through will most likely form the next generation of Slovakian Earth Scientists and need to be encouraged to build their long-term careers in Slovakia.
- Avoid copy-pasting and repetition in Impact and Creativity statements – you have a very limited word count to produce these and every word counts.

- Focus on the questions asked. Do not bleed tangential/background info into answers to specific questions when space is so limited.
- In Impact and Creative Environment statements, try to rise above mere summaries of procedures and legal directives that are followed. In order to award high grades the sub-panel are looking for what is actually done beyond the legally-required framework, and those that scored highly provided excellent depth and detail on, for example, the arrangements they have for supporting staff with caring responsibilities or at different career stages.
- When selecting Social Impact case studies that are to be submitted to an Earth Sciences sub-panel, Institutions should focus more on the role of Earth Sciences either as a primary theme or (in the case of studies with a focus outside Geological sciences in strict sense) emphasize the connection of Earth Sciences as underpinning research in the development of the selected case studies.

4. Observations on ‘typical’ outputs in each quality level

We assessed outputs according to the VER 5-point scale, namely,

1. World-leading,
2. Internationally excellent,
3. Internationally recognised,
4. Nationally recognised,
5. Below the standard of nationally recognised work.

Each output was evaluated using three key characteristics: originality, significance, and rigour. This evaluation is based on the UK Research Evaluation Framework (REF) and we relied heavily on their descriptions of the meaning of these terms.

Originality will be understood as the extent to which the output makes an important and innovative contribution to understanding and knowledge in the field. Research outputs that demonstrate originality may do one or more of the following: produce and interpret new empirical findings or new material; engage with new and/or complex problems; develop innovative research methods, methodologies and analytical techniques; show imaginative and creative scope; provide new arguments and/or new forms of expression, formal innovations, interpretations and/or insights; collect and engage with novel types of data; and/or advance theory or the analysis of doctrine, policy or practice, and new forms of expression.

Significance will be understood as the extent to which the work has influenced, or has the capacity to influence, knowledge and scholarly thought, or the development and understanding of policy and/or practice.

Rigour will be understood as the extent to which the work demonstrates intellectual coherence and integrity, and adopts robust and appropriate concepts, analyses, sources, theories and/or methodologies.

For **world-leading** outputs the work would be agenda-setting and with most or all of the following characteristics that would provide a major influence on a research theme or field.

- Very high originality, sometimes first of their kind or with a major methodological/analytical innovation;
- had clear significance and implications for the disciplinary field beyond that study, and so for example might become an exemplar of a certain type of analysis, or the findings meant a large body of other work would have to be re-evaluated;
- high rigour, either in terms of a thorough approach to a problem, using several independent approaches or methods to address the same question, or undertook a

study at many sites that provided significantly greater insight than would be possible from one site alone.

Internationally-excellent and **internationally-recognised** outputs did not have to derive from work in more than one country. For them to be evaluated with one of these ratings the significance, originality and rigour of the work had to be of such a standard that researchers in other countries and sometimes in other disciplines would be *likely* to read and refer to the papers. Examples of this might be methodological innovations that had more widespread application, or good studies of particular features where others might be likely to need to incorporate that understanding into design of their own research of that feature elsewhere. The main difference between Internationally excellent and Internationally recognized is that the former makes important contributions to the field at an international standard, and contributes important knowledge, ideas and techniques which are likely to have a lasting influence, but are not necessarily leading to fundamental new concepts. The latter provides useful knowledge and influences the field, but involves incremental advances, which might include new knowledge which conforms with existing ideas and paradigms, or model calculations using established techniques or approaches.

Nationally-recognised outputs were those which are potentially useful but unlikely to have more than a minor influence in the field. They were sometimes those where an existing well-known method was simply applied, without modification, as a case study to a (single) study site, and did not provide much new insight beyond the specifics of that site. It would be unlikely that these would be read and used more widely to any major degree in the international community. Lower quality outputs often did not explain what was original or significant about their findings.

We encountered several outputs that did not provide an original contribution to research – they were purely descriptive with new data or insight provided, and these were scored as **“Below the standard of nationally recognised work”**.

Review papers: To be clear we did read some very good *review papers* on some Earth Science topics but also some poor ones. The better reviews scored more highly because they were very clear on how new insight or understanding had been brought to a problem by drawing together larger, existing datasets and they explained this significance very clearly in the paper. The best reviews would often map out, based on the evidence of their review, research priorities (and ways to address these) that would help advance the field. Poor reviews were descriptive or simply listed previous research without new insight.

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