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State of the art in Regional Stratigraphy

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Summary

Stratigraphy analyzes and formalizes rock sequences. Analysis encompasses the description of matrix, mineral - and fossil content, with the aim of determining depositional processes, relative age, environmental and climatic conditions as well as paleogeography. Formalization involves the attribution of a rock sequence within litho-, bio- and/or time-stratigraphic units. While the extent of space in litho-stratigraphic units is forcibly restricted to a territory, often of tectonic nature, but also by national limits, bio-stratigraphy is limited by provinciality, climate and environment. The aim of Time-stratigraphy is thus more of a virtual nature, unit- boundaries being defined at type localities, the process of defining Global Standard Sections and Points (GSSP) having been taken over by the International Commission of Stratigraphy (Gradstein *et al*., 2004), not always reflecting the work of scientists in the field. STRATI-2013 will promote discussions and proposals.

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The main feature of regional stratigraphy is that it defines the geology of a particular region, paleogeographic, structural or tectonic unit, always representing on its own or simultaneously a piece of a wider stratigraphical build-up ranging well beyond apparent local limits. Regional stratigraphy stands out in comparison to other geological branches – because stratigraphical considerations, even at a local scale, become always the basis for a wider interpretation, be it ofsedimentological, paleogeographical or paleo-tectonic nature. The presentations of the session give many examples of such interrelations.

In their fundamental stratigraphical research, Markus Wilmsen, Marisa Storm, Franz Theodor Fürsich & Mahmoud Reza Majidifard presented the stratigraphy and facies analysis of the Upper Albian–Turonian (Cretaceous) Debarsu Formation (Yazd Block, Central Iran). Using an integrated stratigraphical approach they showed the presence of numerous shallowing-upward cycles giving evidence of significant relative sea-level changes. Stratigraphy of sequence-bounding unconformities infer a predominantly eustatic control of the sedimentary cycliclity, while the base of the overlying Coniacian–Campanian unit turned out to be, however, of tectonic origin. Markus Wilmsen & Emad Nagm also proposed an integrated stratigraphy (bio- and sequence stratigraphy) and facies analysis of the Upper Cenomanian–Turonian (lower Upper Cretaceous) in the Eastern Desert, Egypt. They showed that major sedimentary unconformities are strictly comparable with successions from other Cretaceous basins, demonstrating the contemporaneity of the unconformities across different tectonic plates, strongly suggesting their deposition to match eustatic sea-level changes.

In tectonically active regions – detailed stratigraphical and depositional facies analysis provide clues for the environmental interpretation that may lead to the paleogeographical origin of certain deposits, while unravelling main tectonic events and the extent of major strike-slip faults. Keisuke Ishida, Takeshi Kozai and Francis Hirsch researched the origin of Torinosu-type reef limestone blocks in the Upper Jurassic - Lower Cretaceous fore-arc basin deposits that cover oceanic-plate sequences of Permian and Jurassic accretionary complexes in the Outer Zone of SW Japan. The *in-situ* Torinosu- type limestone of the Inner Zone differing, however, in its faunal content, suggests different paleolatitudes, due to post-Jurassic left-lateral strike-slip of over thousand kilometers along the paleo-Median Tectonic Line that presently coincides with the boundary between inner and outer zones of SW Japan. Francis Hirsch, Howard R. Feldman, Fayez Ahmad, Mena Schemm-Gregory and Mark A. Wilson correlated Middle Jurassic units in Jordan, Israel and Egypt, across the Dead Sea Rift. The present apparent juxtaposition of similar units, but with a different faunal content, is due to two events: first the Infra-Cretaceous regional truncation of progressively older Jurassic units, as it progrades from NNW to SSE, and second, the Late Cenozoic left lateral Dead Sea Transform, that offset Western Sinai-Negev and Eastern Jordanian sides by more than 100 km.

The age of meta-sediments such as in the Central Anatolian Complex migmatites, and of volcano-sedimentary complexes in Carpathian and Transcarpathian Ukraine. First, Kerim Kocak constrains alternations of marble and thick meta-carbonate sequences in migmatites of the Central Anatolian complex (Ortaköy). Here, marbles yield fossils that may point to a Silurian-Devonian age, suggesting a stratigraphical correlation with Silurian-Lower Carboniferous rocks, 200 km further WSW. Second, Michał Krobicki, Oleh Hnylko, Anna Feldman-Olszewska & Jolanta Iwańczuk, studying the tectono-stratigraphic units of the Carpathian and Transcarpathian Ukraine, reveal that the latest Jurassic/earliest Cretaceous volcanic-sedimentary complex (Mt Chyvchyn) does not consist in a single nappe, but of four small tectonic units.

But regional stratigraphy is also submitted to rules of formal nature, defined by national entities, often resulting in geological maps being restricted within national boundaries. Such problems related with regional stratigraphy still have a large influence on the general progress in stratigraphical interpretations. In the case of the existence of many local lithostratigraphic subdivisions, which are the basis for geological mapping, Stefan Strasky, Alain Morard, Reto Burkhalter & Andreas Möri looked into harmonising the Swiss lithostratigraphic nomenclature for the Geological Atlas of Switzerland 1:25000 of the Swiss Geological Survey. They elaborated a litho-stratigraphic standard legend, including harmonised descriptions, providing a fundamental base for a seamless, nationwide geological GIS map of Switzerland. They ultimately point out that there is no reason for lithostratigraphic units to stop at national frontiers by incorporating several units defined in France, Germany, Austria and Italy in the Swiss lithostratigraphic framework. They also call for international discussions and correlations with neighboring countries! The problem is related to many other areas, however, where the burden of local lithostratigraphic names hampers progress in a wider stratigraphical correlation. Similar situation exists in biostratigraphy where many local subdivisions, poorly correlated with standard subdivision becomes the barrier difficult to cross for anyone who is not familiar with special groups of fossils. The only way is introducing of the widely accepted standard biostratigraphical subdivisions – and the standard chronozones well defined and well correlated with the local schemes. Here, the correlations schemes giving the general succession of the biostratigraphical units, their definitions, relations to boundaries of the stages and general correlations are especially useful, like those related with the subdivision of the Boreal Russian Volgian Stage in its type area, and the correlation with the Tethyan sections of the Tithonian stage by Mikhail Rogov.

Finally, reviews of entire regional stratigraphical systems, consist in the the state-of-art for the Jurassic Stages in Russia and in analysis of Paleocene-Neogene deposits and their response to the uplift of the of the Tibetan Plateau. First, Victor Zakharov and Mikhail Rogov review the state-of-art for the Jurassic Stages in Russia, represented mainly by Boreal deposits. Secondly, Kexin Zhang, Guocan Wang , Mansheng Luo, Yadong Xu , Bowen Song and, Junliang Ji recognize the stratigraphic sequence of the Paleocene-Neogene of the Tibetan Plateau. These respond to the plateau's uplift process in 3 stages of subduction-collision (65-34 Ma), such as the initial Indian and Eurasian plate-collision, witnessed by the formation of the major rivers, the Indian and Eurasian plate-collision and the disappearance of the Neo-Tethys residue sea in Southern Tibet.

All these examples indicate that there is no regional stratigraphy without a wider context. Thus coming back to foundation of stratigraphy, the basic principles of stratigraphy should be expressed as follows:

1. Stratigraphy has always been and remains a discipline that goes hand in hand with quality geological mapping.
2. Stratigraphy is intrinsically interwoven with the concept of facies (lithology and biotic content) which i.o.w. is defined by petrographical and paleontological methods.
3. Modern stratigraphy has been enlarged with the many disciplines presented in the other sessions, such as Sequence Stratigraphy, Seismic –, Chemo- and Magneto-stratigraphy, some of which challenging our older concepts of subdivision.
4. Among the tools for age determination, macrofossils that had for over a century been the exclusive bio-zonal markers, have since the second half of the 20th century been complemented microfossils. Micropaleontology has taken an increasing part in defining ages and environments, being according to specific time- periods, represented by one or more of the following groups, such as foraminifers, conodonts, radiolarians, palynomorphs, calcareous nannoplankton, acritarchs and others. In Japan, e.g., where prior to this revolution, entire sequences remained poorly dated due to lack of fossils, the use of conodonts and radiolarians have opened new stratigraphical perspectives that, coupled with the emergence of plate tectonics, have changed not only the geological interpretation, but also the entire tectonic vision.
5. Stratigraphy, in one of its modern applications, is the key to the definition of the GSSP and auxiliaries for each stage, necessarily complemented with chemo-, magneto, and seismic stratigraphy as well as paleo-magnetism.
6. The availability of isotope geology widens our theme with paleotemperature and climate, which coupled with disciplines mentioned above, provides clues to paleolatitudes.
7. Finally, a growing harmony between these stratigraphic tools and radiometry (chronology) reveals the real age and time spans of geological units in m.y., and provides a correct time-scale for the physical and biological evolution of the earth.

In how far does the classical stratigrapher of brunton, tape and hammer find its place in this world of computers and all sorts of sophisticated labs? Well, after all, one single fossil can sometimes define on its own the age, facies, paleolatitude, paleogeography and an entire plate reconstruction. And here, we are coming back to the classical stratigraphical rules, still fundamental in our modern times.

References

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