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Integrated Solid Earth Science: the right place and time to discover the unexpected? (Arthur Holmes Medal Lecture)

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The fascination of learning more about the way system Earth operates has driven generations of Earth scientists. This has been the case for early pioneers such as Arthur Holmes, focusing on the geological record in continental settings, as well as for the founding fathers of plate tectonics, who built upon the results of exploring the ocean floor. Two years ago we celebrated the centenary of the discovery by Mohorovicic of the seismic discontinuity that separates the crust from the mantle, which now carries his name. Reading the rocks and mapping the (sub)surface of the Earth has provided the foundation for a great deal of what we conceptually pursue today in developing and validating coupled deep Earth and surface processes.

The **unexpected** is probably characterizing most of my scientific career. It started in 1968 when, as a student, entering the geology program of Groningen University headed by Professor Philip Kuenen, a pioneer in marine geology and sedimentology, the textbook of Arthur Holmes just happened to be my first purchase. It was during those years that plate tectonics drastically changed everything we were learning. I was also privileged to enter a few years later as an MSc student the Utrecht geophysics school at a time where Nico Vlaar as a young professor was developing a vigorous research program with a focus on seismology, attracting and stimulating many talented students. When he and Rinus Wortel started research on Tectonophysics in Utrecht, I decided to go for a PhD research project tackling the problem of the initiation of subduction, a first order problem in geodynamics, with still many aspects to be resolved. This research and the joint work with Rinus Wortel on modeling intraplate stresses in the Faralon, Nazca and Indo-Australian plates led quite unexpectedly to exploring, together with Kurt Lambeck, intraplate stress fluctuations in the lithosphere as possible tectonic causes for the origin of third-order cycles in relative sea-level. Those cycles were detected as a result of the pioneering work on the stratigraphic record of sedimentary basins and continental margins from all over the world by Peter Vail, Bilal Haq and others from Exxon. It was at this time, that sedimentary basins became a frontier in the integration of quantitative geology and geophysics. Sedimentary basins do not only provide a powerful source of information on the evolution of the underlying lithosphere and climate fluctuations, but also contain mankind's main reservoirs of geo-energy and geo-resources. It was Peter Ziegler, head of global geology at Shell International, who was the prime mentor in my somewhat unexpected scientific journey in sedimentary basins. These became the main research target of the Tectonics research group I established in 1988 in Amsterdam. In these years it became increasingly evident that the rheology of the lithosphere exerts a crucial control on the evolution of basins, but also on continental topography. It is on this topic that the cooperation over more than two decades with Evgenii Burov, addressing issues like the rheological structure of Europe's lithosphere, rift shoulder uplift and the interplay of lithospheric folding and mantle-lithosphere interactions, has, been very fruitful. Another unexpected milestone has been the opportunity to build up, parallel to the research efforts in field studies and numerical modeling, an analogue tectonic laboratory in our group. This brings me to another issue, also completely unforeseen: the integration of earth science in Europe, particularly taking off after the disappearance of the Iron Curtain. For my group, the latter marked the beginning of a very fruitful cooperation in particular with the groups of Frank Horvath in Budapest and Cornel Dinu in Bucharest, addressing the fascinating solid Earth dynamics of the Carpathians and Pannonian basin.

Over the last few years, it has been become evident that integration in the solid earth science is the way to go. Not only on a national level, such as pursued by the Netherlands Research School of Integrated Solid Earth Science (ISES), but also on a full European scale, such as the TOPO-EUROPE research program. This goes hand in hand with setting the stage for a pan-European research infrastructure for solid earth science by the European Plate Observing System (EPOS).

Much of the unexpected remains to be discovered. The Holmes medal awarded by the European Geosciences Union, itself an example of the immense progress European earth scientists have made in joining forces, means a lot to me. I share it with my co-workers in my group, the close to 70 PhD students who worked with us, and other numerous colleagues and friends that all contributed immensely to the unexpected.