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Chemostratigraphic characterization and correlation of lower Silurian (Llandovery) strata across the Baltic Basin

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Over the duration of year-2 of this DNI project we have had all major geochemical analyses for the project carried out, one paper submitted and published, and a second paper is currently in preparations for submission to a journal. Over the last year my Masters student finished her MS thesis and graduated in May of 2019, currently her thesis (focused on the Aizpute-41, western Latvia and Röstånga-1, Sweden drill cores) is being prepared for journal submission (Figures 1 & 2). From these refined data sets we can see robust signatures of two globally recognized carbon burial events (i.e., they have been documented outside of the paleocontinent of Baltica), the Late Aeronian carbon isotope excursion (CIE) and the Valgu CIE. The sulfur isotope data support these two CIE's as being the result of carbon burial under increased anoxic marine conditions globally as we see >10‰ shifts in pyrite sulfur isotopes that indicate enhanced pyrite burial was also occurring at the same time. Furthermore, the local paleoredox proxy Fe-speciation data ($Fe_{HR}/Fe_{T} > 0.22$) from both cores demonstrate that anoxic marine conditions spread from deeper basinal environments to distal shelf settings during the Aeronian Stage of the early Silurian. These iron speciation data suggest that while anoxic conditions during the Aeronian may have been more wider spread they were largely not euxinic (anoxic + sulfidic conditions). When this data is integrated with the trace metal data, regional paleogeography, and sea level records we find good evidence for these sediments have been deposited under an oxygen minimum zone (OMZ) and that these reducing conditions within the OMZ likely expanded during the Aeronian Stage in the Silurian. These results thus far have allowed us relate our geochemical signatures from ancient marine sediments (~ 440 Ma) to modern day geochemical and microbial processes that have been documented in OMZ's off the coasts of Peru, Argentina, and Namibia (e.g., Algeo et al., 2009; Hardisty et al., 2018; Scholz, 2018). By comparing our new geochemical data sets to geochemical data sets from modern day OMZs it has allowed my research group to broaden the impact of our findings in these ancient marine sediments, by utilizing uniformitarianism concepts we are now beginning to reconstruct early Silurian paleoceangraphic conditions on the margin of the Baltic paleocontinent and demonstrate physical and chemical oceanographic conditions that operated in early Paleozoic oceans. Additionally, my PhD student has carried out a wide variety of detailed geochemical analyses on drill cores (Röstånga-1, Röstånga-2, Grönnhögen-2015, Lerhamn, and Krapperup) from southern Sweden collected during project year-1, including: $\delta^{13}C_{org}$, $\delta^{34}S_{pyr}$, Fe-speciation, and trace metal concentrations (e.g., [Mo], [Cr], [V]), [U]). He is currently in the writing stages of his first chapter of his dissertation, with the ultimate goal of his first PhD-manuscript submission to a top-tier journal by December 2019.

More broadly, this project has allowed for the completion of one Masters student working on two of the Silurian drill cores mentioned above, giving her valuable geochemical skill sets that she may apply in future jobs or academic pursuits. It has provided valuable support (RA and funds for geochemical analyses) for a new Masters student working on another Silurian drill core collected during project year-1. And it has provided ongoing support for one PhD student and parts of his dissertation projects. More broadly these research projects that both graduate and undergraduate students have worked on have given them real laboratory experiences, experiences operating state-of-the-art equipment at the National High Magnetic Field Lab (NHMFL), and experiences in time management, project deadlines, working in teams, and communicating their findings to their peers at conferences. Additionally, the field work and samples more recently carried out by my PhD student and new MS student allowed them to collect preliminary data that he used to submit graduate research proposals to GSA, and both were awarded Spring 2019. These new data also allowed me to submit (proposal submitted June-2019) a full collaborative NASA-Exobiology research proposal to continue this geochemical work into Ordovician organic-rich black shales from Sweden where we will be utilizing the above mentioned geochemistry in addition to a new novel proxy, thallium isotopes, for global ocean oxygenation to test the hypotheses and new models put forth about oxygen's role in Earth's second largest radiation of marine life, the Great Ordovician Biodiversification Event (GOBE). These forthcoming projects on Ordovician graptolitic black shales from Sweden and the United Kingdom will involve new collaborations with researchers from FSU, Lund University (Sweden), and several universities within the U.K. Lastly, this project thus far has allowed me and my research group to develop new geochemical skill sets and methods in our laboratory here at FSU and the NHMFL, solidify good working relationships colleagues here at FSU, Lund University and Tallinn University of Technology, and to be able to gain valuable experiences mentoring the next generation of geoscientists at both the graduate and undergraduate levels. I anticipate at least two more publications from this ACS funded project, these manuscripts will be submitted in November to *Palaeogeography, Palaeoclimatology, Palaeoecology*, and December to *Earth and Planetary Science Letters*.

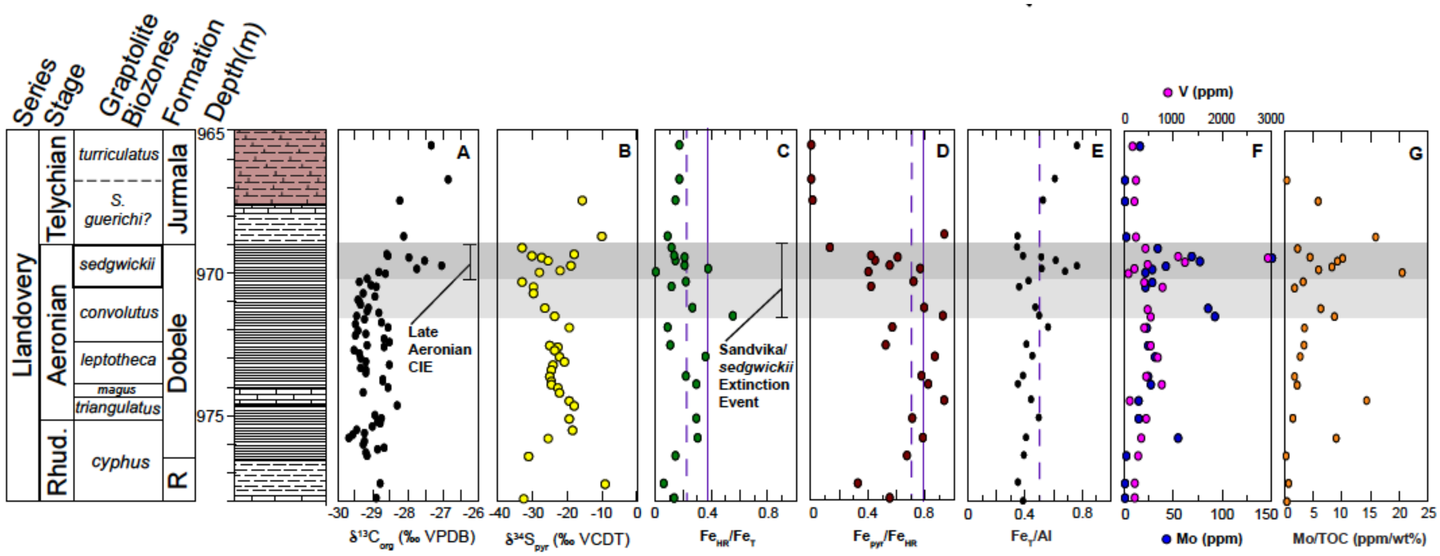

Figure 1, Geochemical data from the early Silurian–Aeronian interval of the Aizpute-41 drill core. Note coincidence of anoxia/euxinia indicators with global extinction event.

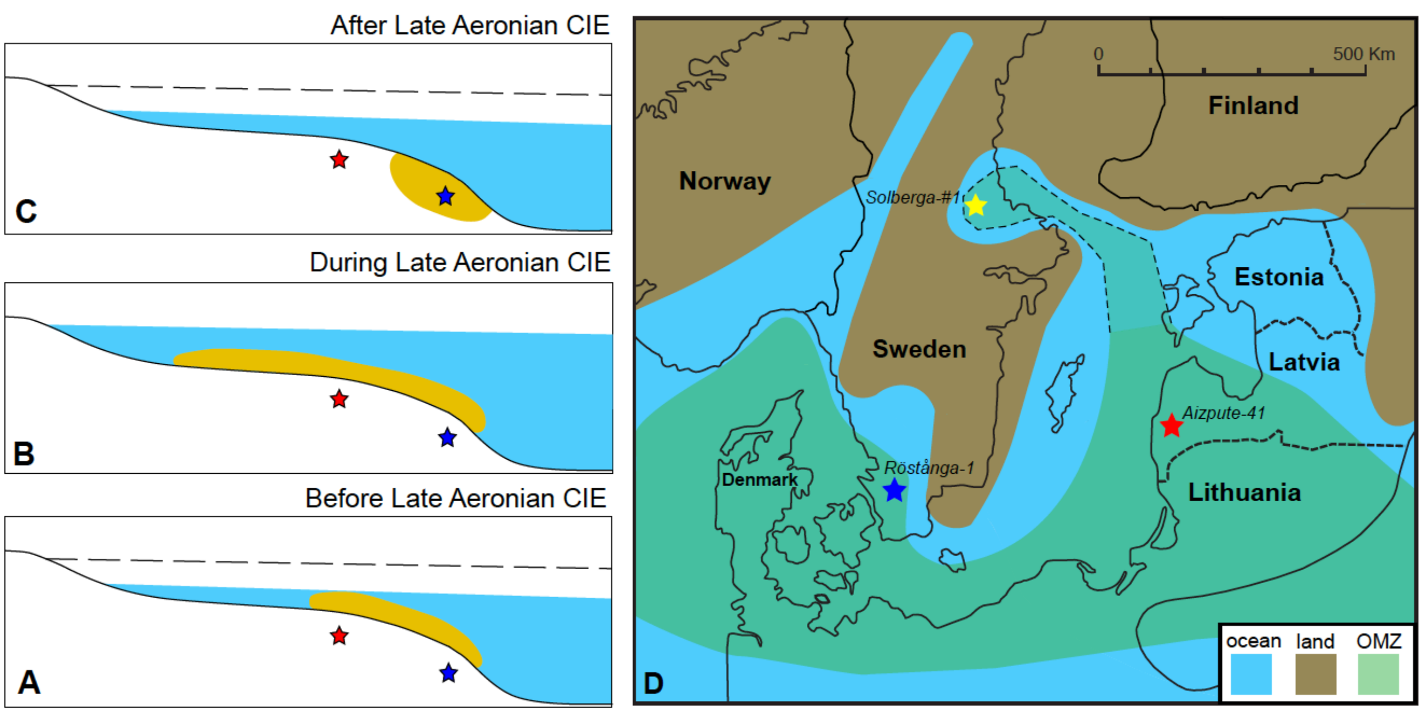

Figure 2, Paleoceanographic model for the Late Aeronian that is based upon our local redox proxy data collected from the Baltic Basin combined with previous work of Lu et al. (2017).