EGU21-9024, updated on 21 May 2022
https://doi.org/10.5194/egusphere-egu21-9024
EGU General Assembly 2021

Early-Middle Devonian paleosols and palustrine beds of NW Canada in the context of land plant evolution and global spreads of anoxia

Pavel Kabanov
Geological Survey of Canada, Natural Resources Canada, Calgary, Canada (pavel.kabanov@canada.ca)

Knowledge on the early development of vegetated landscapes mostly arrives from the floodplain successions where both paleosols and plant body fossils can be assessed. Due to better preservation in the sedimentary record, the shallow-marine carbonates avail much broader areas of former land surface preserved at disconformities, although the associated fossil floras are usually not preserved there. This study demonstrates how much can be learned from this underused sedimentary archive. Many dozens of subaerial exposure surfaces are assessed in cores from cyclic peritidal carbonates of the Emsian – early Eifelian age. These surfaces range from incipient erosional surfaces with few solution features, through paleokarst profiles penetrating to ≥1.0 m underneath disconformities, to thick (>1m) calcretic-clayey paleosols where the parent limestone is ultimately disintegrated into floatbreccia. The studied succession also contains numerous palustrine carbonate intervals, which is the earliest known occurrence of a typical palustrine facies in coastal carbonate plain environment (calcimagnesian paleo-landscape) and is nearly coeval with the earliest occurrence of palustrine facies in the floodplain succession of Svalbard. None of paleokarst and paleosol profiles contain traces of vascular-plant root penetration, and only palustrine facies exhibit swarms of thin (0.5-1.5 mm in diameter) rhizoliths. These findings are within the context of Devonian paleosols on marine carbonate substrates where root traces and laminar calcretes are extremely rare, and no instances of root penetrations are trackable from pre-Givetian, as well as from the Famennian carbonate strata. Despite $\delta^{13}C$ and $\delta^{18}O$ signatures demonstrating partial diagenetic reset of isotopic composition in studied formations, the moderate $\delta^{13}C_{vpdb}$ offset towards lighter values is detected in two thicker paleosols (-3.0 to -8.0‰ in calcretic matrix vs. -1.0 to -4.5‰ in parent limestone). However, instances of $\delta^{13}C$ offset in pre-Late Devonian calcretes are rare and their attribution to plant-derived CO_2 is doubtful. It is inferred that the land surface in calcimagnesian landscapes remained a primary desert long after the advent of vascular plants in more favorable wetland settings. Furthermore, for the entirety of Devonian and well into the Carboniferous time, the area involved in primary deserts (surfaces never colonized by embryophytes) must have been much broader than the vegetated conduits of continental runoff, as seed reproductive strategy emerged only in the mid-Famennian, and no plant adaptations to aridic habitats enter the fossil record until Pennsylvanian. The embryophytic green cover of even older, pre-Devonian land was confined to very specific amphibian loci. The negligible biomass this pioneer, ground-level green skin was likely able to achieve contests the hypothetical link between the emergence of thallophyte-grade vegetation and the Late Ordovician event of atmospheric oxygenation and decarbonization. The very gradual,

on the scale of first hundred(s) Myr, evolutionary expansion of land plants and correspondently slow increase in their aerial coverage and biomass, is at odds with the hypothetical teleconnection between the spread of terrestrial vegetation, Devonian anoxic events, and biotic crises in the marine realm. Eruption activity in LIP(s) was likely a main driving force in the mid-Devonian switch to the widespread anoxic deposition in shelfal seas known as the Kačák Event.