

*j*5 Devonian geology of the ORS paleocontinent < Laurentia, Paleobaltica, and Avalon, joined >

These fossils meant no disrespect, but they did mean that a modest fact in the hand of anybody who knows enough to appreciate its value is entitled to take precedence before all “canons” however old, and before all authority, however, respected. —Henry Shaler Williams, October 5, 1884, to James Hall.¹

Southern Laurasia, a realm, the other being Gondwanaland, of Pangea-to-be during the Early Permian and Pennsylvanian was earlier, during the Mississippian and the Devonian, a separate paleocontinent called the “Old Red Sandstone (ORS).” That name long predates the theory of plate tectonics and refers collectively to regions (now separated by deep oceans and not downwarped sial as once thought) in which accumulations of Devonian continental red sandstones (molasse) are widespread.

The western part of the Old Red Sandstone (ORS) paleocontinent was flooded by the Kaskaskian epeiric sea. The Kaskaskian flooding is divided into a younger phase, the Mississippian Tamaroa sub-sea that a brief withdrawal of the Kaskaskian at the end of the Devonian separates from an older phase, the Piankasha Devonian sub-sea.

Marine fauna in basal Tamaroan sediments of Chautauquan (**Figure *j*7.1**, p. 539) age include an abundance of marine glass sponges (Hexactinellida: siliceous 6-rayed spicules) that (by inference from living communities found only below the thermocline and in polar regions) record frigid water.

The Tamaroa seaway was muddy during its onlap phase. Its legacy is the lithological marker formation that separates the Tamaroa and (older) Piankasha sub-seas: a thinly bedded, usually less than 10 meters thick, mostly unfossiliferous black shale either non-calcareous carbonaceous nonmarine or bituminous marine that historically has served as divider between the Mississippian and the underlying (older) Devonian limestones and is easily traceable over a vast area of the eastern and middle United States. This formation is exemplified by the Chattanooga shale, Tennessee.² It has rare marine fossils (except for conodonts) and none are of benthic marine shellfish. It contains a high organic carbon content, phosphate minerals, iron sulfide, and uranium mineralization. These are environmental indicators of a shallow, stagnant, euxinic (anoxic and sulfidic) bottom waters below high productivity, wave-stirred, oxygenated, surface waters. Pioneer geologists assumed that this black shale formation recorded deep foundering of the continent. Since the revolutions in geology that followed upon the acceptance of the principle that widespread continental formations are time transgressive, and that continents cannot founder, the explanation for the shale became that it represents the basal facies of the Tamaroa sub-sea transgression. This interpretation is consistent with its widespread deposition. Also, the absence of clearly related lateral facies and only sporadic fossil caches (age spanning Early Mississippian and Late Devonian), suggest that the whole was deposited piecemeal. During that time, the black shale accumulated in a shifting, narrow in width, shallow, marine environment. The lack of below wave-base stirring, which allowed for anaerobic conditions (atypical for the advancing edge of an epeiric sea), is postulated to have been due to a blanketing, floating vegetation. In Europe, calcareous mud mounds occur in shales of the Frasnian stage.

As mapped today, the Transcontinental Arch during the Piankasha inundation was emergent between western Canadian and eastern Catskill, Devonian, seaways. The latter was muddy as Catskill deltaic sediments prograded into it from the east.³ West of these molasse sediments, turbidite-deposited flysh sediments accumulated. Representative of the flysh are the Late Devonian black shales, northern Ohio, in which occur fossils of the giant placoderm *Dunkleosteus*. Brachiopods, ammonoids, gastropods, and trilobites that occur are rare extinction survivors of a diverse abundance in the lower Senecan (upper Givetian) stage. At first, the waters of the Piankasha had everywhere been clear and warm enough to allow for the growth of extensive biostrome reefs of stromatoporoids, tabulate corals, and rugose corals. In western Canadian, these now subsurface, porous, reefs are

important reservoirs of migrated-oil that is trapped in them. More than half the world’s potash (K) in agricultural N-P-K fertilizers (**Footnote j5.1**) is from Devonian backreef evaporates in Alberta.

The distinctive red sandstone (molasse) formation of the ORS paleocontinent (**Figure j5.1**) are remnants of foreland clastic wedges to either side of fold mountains that formed along the suture line between Avalonia paleoterrane and, continuing it southward, that between earlier joined Laurentia and Paleobaltica paleocontinents. The ocean that closed is called the *Iapetus* (in Greek mythology, this is the name of father of Atlas for whom the Atlantic is named).

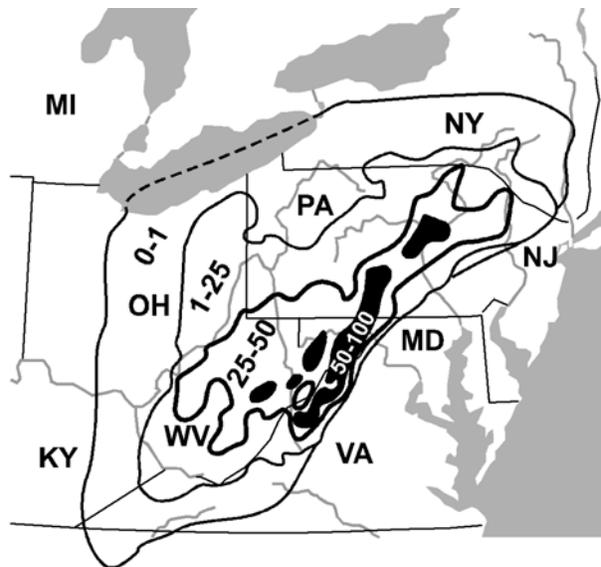
The Devonian deltaic red-sandstone formation that accumulated on the Paleobaltica and Avalon realms of the ORS paleocontinent were described and named originally from occurrences in Great Britain. Mirroring these are same-age red sandstones shed the other way onto the Laurentia realm of the ORS paleocontinent. These, preserved today in the Catskills mountains, eastern U.S., comprise a well exposed formation. Its wedge-shaped cross section is 1,800 meters thick in Pennsylvania and New York, and thins to 500 meters in Michigan.⁴ Lateral facies in this molasse wedge, going west, are: fan gravels, braided-stream cross bedded red sands, meandering-stream sandstones and shales, tidal-flat sands and muds, barrier-beach sands, marine muds, and fossiliferous limestones.

Widespread Early Devonian limestones lap onto both sides of the Transcontinental Arch. Away from there, the limestone is free of terrigenous sediment (and this is evidence that the Acadian orogeny did not begin until the end of the Early Devonian).

Clastic sediments of Early Devonian age are the Oriskany Sandstone. This is a basal transgressive formation of the Kaskaskian sea. The Oriskany Sandstone is a clean, almost pure, quartz sandstone. It exists extensively in the eastern United States today (**Figure j5.2**) and where quarryable is of economic importance for glass making.⁵ □

Figure j5.2⁶ Early Devonian Oriskany Sandstone (thickness contoured in meters) is an important source of high-purity silica powder and sand for glass manufacture and is also an important gas producer throughout the central Appalachian Basin. Gas reservoirs are in both structural and stratigraphic traps. These generally consist of very low porosity and low permeability sands (“tight” reservoirs). To enhance yield, the sands are, commonly, hydraulically fractured, or are acidized.

Footnote j5.1 Legumes long supplied N until in 1909 Fritz Haber “plucked bread [N] from the air.” And soot long supplied K. For P, John Bennet Lawes (1814-1900) developed superphosphate in 1942 by dissolving bones in sulphuric acid at the ongoing experimental farm at Rothamsted, Hertfordshire, UK, and which patented in 1843 marked the beginning of the chemical fertilizer business.⁷



Suggestion

You must not pay a person a compliment, and then straightway follow it with a criticism.
—Mark Twain *Notebooks*.⁸

The retention of the American subdivision of the Carboniferous period into two periods is laudable. But naming the younger Pennsylvanian (economically important for its coals, which accumulated in Southern Laurasia, a realm of Pangea-to-be) and the older Mississippian (with reservoirs of oil and natural gas, and with limestone, fluorspar, and building stones, which accumulated in the ORS paleocontinent) is regrettable for their difficult spelling and a clear need to choose short names when they will surely be used for column or row headings in tables! (Try *Pennsic* and *Missian*.)