SOUTHERN LAURASIA

The area of Asia east of the Ural mountains (excluding S. China and India) was **Northern Laurasia** (a realm).
The areas of N. America (excluding Florida), Greenland, Europe and Baltics were **Southern Laurasia** (a realm).
Florida, S. America, Africa, India, Australia, and Antarctica are fragments of what was **Gondwanaland** (a realm).

Pangea, which existed during the early Mesozoic, comprised three realms:
Northern Laurasia, **Southern Laurasia** (also called *Euramerica*[1]), and **Gondwanaland**.

i15 The Permian < evaporites, redbeds >

Pangea was completed just after the beginning of the Mesozoic by the joining of N. Paleochina (***Figure i15.1***) as the N. China subrealm of Northern Laurasia (Pangea's northern and last realm to form) that was comprised otherwise of sutured Siberian and Kazakhstanian subrealms. During the Permian, the Urals came to be as a narrow ocean closed between Kazakhstanian (a subrealm of assembling Northern Laurasia) and Southern Laurasia (the central realm of assembling Pangea).[2] Terrestrial sediments filled the foreland on the western side of the emerging Urals. These are the red beds that Murchison in 1841 formally described as the type system of the Permian Period.[3] Then Panthalassa, a paleo-ocean, stretched from pole to pole and spanned 300 degrees of longitude![4]

During the Permian, Southern Laurasia was between the Ural intracontinental mountains forming on its east and an ancient chain of high intracontinental mountains along its southern-boundary suture with Gondwanaland (the southern realm of assembling Pangea). On its north and west margins no coastal mountains of any permanence arose. In those directions, the Southern Laurasia realm stretched as a lowland and wide continental shelf out to a fossa (a bordering deepsea trench). Sediments washed from the intracontinental mountains, accumulated on the lowland and its near offshore. Where preserved today, these, have a striking red color. The red color could have developed by weathering of the ground above lowered water tables at times of drouth, which intercalations of evaporite beds evidence. Elsewhere, the continental shelf accumulated shelly limestones. In the southwest of its lowlands, a prolonged local basinning produce among others the Oquirrh (pronounced *ochre*) basin. The basin fills now have exposures in the Wasatch and Oquirrh mountains, Utah, and several basin-rimming reefs made famous by Philip Burke King's pioneering study of them, have dramatic exposures in the Glass mountains, western Texas,[5] and in the Guadalupe National Park, southeastern New Mexico [6] (***Figure i15.2***). The dark-gray color of turbidity-current sediments in the basins record times when subsidence was faster than filling and when low oxygen to anoxic conditions existed in the bottom waters. Oil production, in vast quantities, from porous reef rock in the basin sediments, early led to deep-drilling exploration. Here, of anywhere, is the most stratigraphically complete and studied Permian, and, as a bonus for stratigraphers, it is conformable upon the Carboniferous to the base of the Mississippian. The Oquirrh Permian & Carboniferous Group is over 7000 meters thick!

An epeiric sea, called the *Absaroka*, offlapped Southern Laurasia during the Permian. The uppermost formation, in long subsiding Permian marginal basins, are gypsum and halite evaporites that record restricted circulation in a tropical climate zone. These economically important deposits occur in Kansas where earlier had been accumulating limestone (which in its lateral extent is best known where exposed as the impressive vertical cliffs of Kaibab Limestone along the rim of the Grand Canyon). Also, in the subtropical part of Southern Laurasia, Late Permian evaporites overly shelly limestones.[7] In Germany are thick potassium salt deposits that accumulated in the Late Permian Zechstein epeiric sea where this had flooded in from the north. Evaporites of halite and gypsum are a large part of the Upper Permian in the "type area" section of the Urals.[8]

On the western shelf, (wind pumped, or current driven) upwelling of phosphorus-rich seawater deposited the Permian Phosphoria Formation (Montana and Idaho). The Phosphoria is composed of dark phosphatic shales, phosphatic limestones, and dark-gray concretionary phosphorites, interbedded with cherts, sandstones, and mudstones. Phosphorite is mined as a fertilizer and for chemical products. (Phoshorites are forming today off the west coasts of Mexico, Peru, and southern Africa. The special conditions for these are low oxygen and acidity (pH <7) that decomposition of settling planktonic matter maintains in cold deepwater where surface production is high. Upwelled, this water degases (due to lessening pressure and warming). As CO_2 is lost, dissolved calcium phosphate precipitates. Phosphorites of all known occurrences (as reviewed in Cook & Shergold, 1986) have formed within 40 degrees latitude of the paleoequator).[9]

The fossa on the western side of Southern Laurasia, received turbidite sediments from offshore volcanic island arcs. Collisions of some of these with the continent margin are recorded by conglomerates and angular unconforrnities. The related end-Permian "Cordilleran" disturbances are called the *Cassiar orogeny* in British Columbia, and the *Sonoma orogeny* in southwestern U.S.

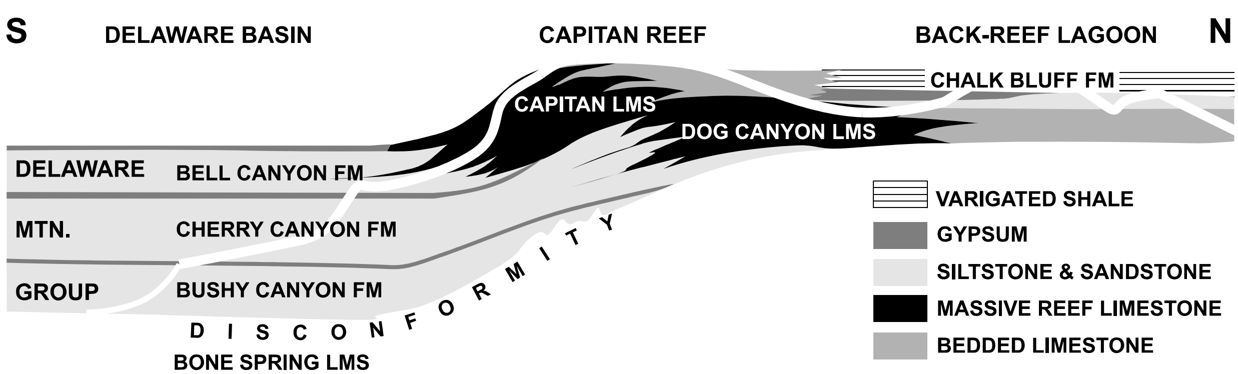
Permian correlations

... the original Permian has never to this day yielded a single ammonite! —Dunbar.[10]

The choice of terrestrial fossils as type fossils for a period is a poor one and so Alexander Petrovich Karpinsky (1846-1936) extended Murchison's Permian (***Figure i15.3***) in its type area to include conformably underlying marine sediments. These marine sediments have fossils (brachiopods and ammonites) correlatable with those in strata that elsewhere overly Carboniferous strata. Problem: the fossa and continental-shelf covering sea of the "type area" Permian was in temperate latitudes. Its fossils are few and of little variety. A far richer marine fauna existed in tropical Permian oceans where, most useful for detailed correlations and facies studies, are found fossilized many genera and species of fusuline foraminifera. In the tropical Permian seas were reefs with distinctive Permian brachiopods. These include *Prorichthofenia* that had converged on extinct solitary rugose (horn) corals that once had inhabited similar reef environments.[11]

How difficult long-range correlations can be was made clear by Robert E. King's study of the Leonard and Kaibab epeiric seas. These have very different fauna even though they are close to each other *and* interiorly connected.[12] The Leonard faunas, contain abundant Permian fusulines, many Permian ammonites, and 81 species of distinctive brachiopods of 30 genera that appeared in the Permian. By contrast, the Kaibab Permian faunas, Carl Owen Dunbar (1891-1979) reported in 1941, never yielded a fusuline, or an ammonite, except for a rare species of *Waagenoconcha*.[8] Its 22 species of brachiopods, described by Edwin Dinwiddie McKee, can be assigned to 15 genera of which only two appeared in the Permian, while the others were persisting from the Pennsylvanian.[13] ❑

Figure i15.2 **Guadalupe Mountains geology**, south-north cross section (restored above the white line) of the Guadalupian stage (second to last stage of the Permian)[14]



Solution erosion of Late Permian evaporites of gypsum and halite have exhumed (white line shows present land surface) the Capitan reef, and valley erosion exposes sections of the strata to either side. Because of the massive (non-layered) limestone reef in between, correlation of these strata with each other was made difficult as they do not intertongue. Originally, the limestone facies strata of the backreef lagoon were (incorrectly) considered to be Cretaceous. This was in accordance with the assumption (and classic mistake of relying on lithological comparisons for correlations) that Murchison had made in the type area of the Permian. Also, on the basis of lithology, the siltstone and sandstone detrital facies strata of the Delaware basin were assumed to be Permian (even though these are not oxidized to the usual bright-red color of Permian detrital sediments). Finally, same age correlations of the strata of the different facies either side of the reef were found by Phillip B. King and Robert E. King in 1931 using fossils.[15] These are different to either side as:

The Delaware basin's bottom waters were low oxygen (in which sponges and snails were the only large benthic life) to anaerobic. Its commonest fossils are of forms which arrived in turbidity-current suspension (fusulinid formaminifera) or died and settled (conodonts, radiolarians, and ammonoids).

The backreef-lagoon waters were well oxygenated and its limestones are abundantly fossiliferous (fusulines, clams and snails).

By contrast the reefcore is massive, its calcareous fossils (algae, sponges, stromatolites, lacy bryozoans, and spiny brachiopods) are mostly vanished as a result of diagentic processes that converted it to dolostone. In the forereef talus, however, its fossils and washed in fusulines are preserved in detail by silicification.

Figure i15.3 [10] **Generalized columnar section of the type Permian of Russia**

The original Permian type section that Murchison formally recognized included only the Tartarian, Kazanian, and Kungurian. The type fossils he described and recommended for use in correlation were fossils reptiles, stegocephalians and land plants of the non-marine Tartarian. The Kazanian is marine but the brachiopod fossils he described from it were few in variety. The Kungarian, although locally extensive and economially important with its vast volumes of anhydrite (oblique shading) and salt (quadrille shading) has very limited faunas. Except for its historical importance, Murchison's type Permian was, in Carl O. Dunbar's words "a poor standard for international correlation."[10] Muchison had considered the limestones below his Permian to be Carboniferous (from their lithology) but A. Karpinsky added the Artinskian to the Permian because his analysis of its ammonite fauna in 1889 showed these to be like those in marine strata (the Trogkofel limestone of the Carnic Alps, the Sosio beds at Palermo, the *Productus* limestone of the Salt Range, Utah) that had been assigned to the Permian because they overlay the Carboniferous.[16] So the fossils (ammonites, brachiopods and fusulines), which are used to recognize the Permian today, are from stratigraphically bracketed assemblages (between the Triassic and the Carboniferous) outside of Russia, and include few from the original type area.