

Worldwide Occurrence of Persistent Sedimentary Layers

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Most individual depositional events in modern environments are episodic and spatially restricted, resulting in low net rates of sedimentation. This means that present sediments tend to accumulate laterally rather than vertically, often having the shape of small “tongues” or fans that build sideways instead of forming distinct layers upon layers traceable over a wide area.¹ Massive carbonate rocks also compose a significant portion of the sedimentary record, including limestone deposited in ancient shallow water environments over the continents. At the present, carbonate rocks form mostly on relatively narrow continental shelves and deeper marine basins. Some geologists believe that this is a serious problem for the interpretation of ancient sedimentary layers because, in many parts of the world, major portions of the sedimentary record consist of widespread laterally continuous units. I will discuss a few remarkable examples here.

The so-called “Germanic” Trias is a succession of layers capped by the red sandstone beds of the Buntsandstein, interpreted as deposited in continental areas during the Triassic. This succession of layers was first defined in Germany and extends throughout much of central and northern Europe, under the Baltic Sea, England, the Alps, and eastward into Bulgaria. I have seen it in outcrops of significant extension in Spain.

Similar Trias rocks also occur in the High Atlas of Morocco. Equivalent Triassic rocks crop out in large areas of the eastern seaboard of the United States, and, to the West, they are represented by

the Moenkopi Formation and the red beds of the Chinle Formation of Arizona, Utah, and Colorado. The layers of the Chinle Formation have a characteristic reddish color and are interpreted as being the result of deposition in channels and floodplains of a large river system. In Mexico, Triassic red beds occur in the Sierra Madre Oriental. In Bolivia and Argentina, Triassic red sandstone beds are interpreted as deposited in fluvial and alluvial environments, extending over hundreds of thousands of square kilometers on the South American continent.

Another example of widespread deposition are the massive fossiliferous Cretaceous limestones commonly called the "Urgonian facies." In the Iberian Peninsula, these limestones are found along the coast of southern Portugal, in east-central Spain, and in the Basque region in the north. They form spectacular cliffs south of Marseille, cap the Jura Mountains in the east of France and west of Switzerland, and are exposed in the eastern Carpathians, in the Balkan Mountains, in the Crimea Peninsula, and in the Caucasus Range. Comparable limestones are seen in northern Africa, from southern Morocco to southern Tunisia, and I have seen similar rock layers just south of Monterrey, Mexico. This geographic distribution portrays a massive limestone that developed over a wide area more or less synchronously in the past.

The Jurassic Tithonian limestones extend over much of the same territory as the overlying "Urgonian" limestones. The Upper Cretaceous chalk layers that extend through northern Europe, England, eastern Europe, Turkey, and Egypt, are also found in Australia and the United States. Massive limestones of the Lower Carboniferous occur in the Appalachian Mountains, Arizona, the Canadian Rockies and Alaska, western Europe, India and Pakistan, and Western Australia.

Other widespread rock formations could be mentioned here that characterize a significant section of the geological column on our planet. The picture emerging from these examples is one of geographical persistence in rock lithologies. However, alongside this

remarkable extension of rock lithologies there is also paleontological persistence: fossils found in those widespread layers tend to be similar across provinces, regions, and even continents. Groups of organisms appear abruptly, not gradually, in the fossil record, and many of them with a worldwide distribution.

Several problems arise when trying to explain these extensive layers and the widespread distribution of similar fossils within a standard geological framework of slow deposition over millions of years. First, compared with what we infer from the study of ancient environments, processes of sedimentation in modern marine and terrestrial environments are of much smaller scale, forming only relatively thin layers spread over small areas. This suggests that in the past, sedimentation must have occurred on a much larger scale both in volume and lateral extent. For example, it has been suggested that some layers in the western United States formed from sand transported from the eastern side of the continent² by fluvial systems at least 1,200 km wide, which is much wider than the largest fluvial systems in modern times.³

Second, most of the ancient layers show flat surfaces of contact without much evidence of erosion in between. This suggests that sedimentation must have occurred much faster than in the present, as layer upon layer accumulated with minimal time in between to allow for erosion.

Third, as indicated earlier, fossils in these widespread layers show a persistent occurrence across regions and even continents. For example, Eocene limestone rocks containing fossils of nummulites (small, one-celled organisms with a chambered shell) occur in Tunisia, offshore Lybia, Egypt, northern Italy, the Pyrenees, the Carpathians, southern Turkey, Pakistan, India, southwest Africa and Madagascar, Venezuela, Brazil, Mexico, Cuba, and other regions of the Americas. Not only is the distribution wide, but the density of nummulites in the rocks is usually extremely high (geologists call these layers “nummulite banks”), much more than expected from “normal” accumulation in modern environments.

Fourth, preservation of fossils in these persistent layers is commonly very good or excellent, something not expected when burial of biological remains is slow. The excellent degree of preservation of fossils points to rapid burial, often associated with mass burial as well.

In conclusion, a large portion of the sedimentary record consists of widespread layers that cover hundreds of thousands of square kilometers with similar lithologic and paleontological characteristics over several continents. These features are better interpreted in a model that invokes large-scale, catastrophic deposition rather than steady, slow accumulation over millions of years.

NOTES

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3. RH Rainbird, NM Rayner, T Hadlari, LM Heaman, A Ielpi, EC Turner, RB MacNaughton. Zircon provenance data record the lateral extent of pancontinental, early Neoproterozoic rivers and erosional unroofing history of the Grenville orogen. *Geological Society of America Bulletin* 2017; 129(11–12):1408–1423.

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