d14 Cenozoic correlations < forams, bentonites >

> The comparison of stratigraphical successions in different countries ... came to be supplemented more and more by the use of fossils. At the same time the other earlier criterion, that of topographical position, proved to be irreconcilable with the use of fossils. Brongniart, for example, showed in a memoir *On the zoological characters of formations* (1821) that the distinctive fossils of the Chalk could be found in a hard black limestone outcropping more than 2000 metres above sea-level in the Savoy Alps; and in a second memoir two years later he showed that the Tertiary fauna of the Paris region could likewise be found at high altitudes in the Vicentine Alps. —Rudwick.[1]

Cenozoic worldwide correlations are made by comparing the fossil content of marine strata.[2] The fossils mostly used for these correlations are: foraminifera, gastropods, and pelecypods, in shallow water environments, and coccolithophores, planktonic foraminifera, and radiolaria, in oceanic ooze. Land faunas and floras are then linked to these where continental and marine strata intertongue (intercalate, interdigitate) (***Figure d14.1***).

Time-horizons and formation boundaries cannot be assumed to be parallel.[3]

Volcanic ash beds and volcanic tuffs (that in the long term persist as distinctive montmorillonite-rich clay alteration products called *bentonites*) can allow for precise correlations where they are traceable from oceanic into continental environments. Bentonites themselves are correlated by "fingerprinting" (chemical composition of glass-shard phenocryst assemblages, melt inclusions, and whole rock geochemistry), by K/Ar and U/Pb radiometric dating, and, in the subsurface, by wireline logs.[4]

Bentonites that cross facies boundaries, when numerous in succession (as say in the Late Cretaceous of the western interior of North America)[5] facilitate detailed fossil correlations that cross facies boundaries and are often easier to use than biozones, especially so when prominent biozones are not present.

Geochemical signals can be used for global correlations. For instance an abrupt global warming (by up to 7 degrees Celsius)[6] that lasted 40 thousand years (a moment geologically—and our world is poised for this again) is recorded by oxygen-18 (a proxy for environmental temperature) in 55 million year old carbonate fossils. This *Late Paleocene Thermal Maximum* caused change in both marine and terrestrial biota.[7] It is best modeled by the melting of methane hydrate (a clathrate that at pressures, which exist in deepsea continental-rise sediments, forms by trapping methane molecules, CH_4, in lattice cages of ice) and so the release into the atmosphere of vast amounts of methane (that has 20 times the heat-trapping power of CO_2) at concentrations that prolonged its usual 12 year residence time (it oxidizes to CO_2) in the atmosphere.[8] ❑

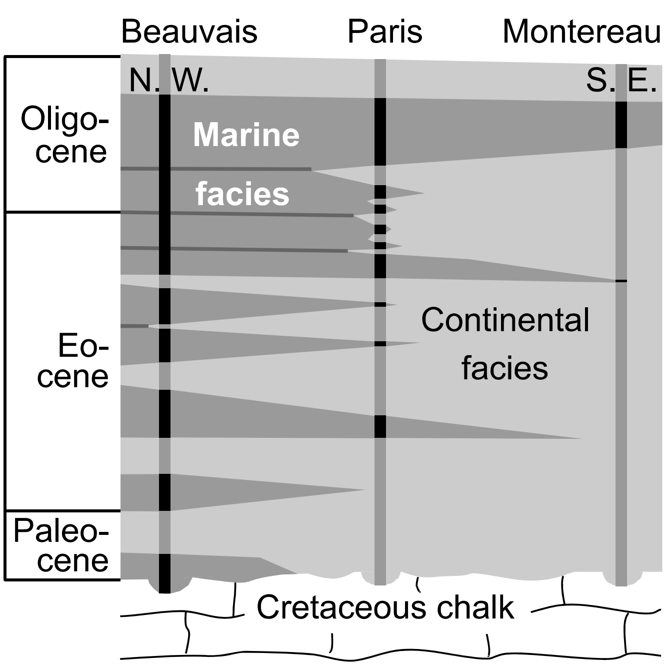

Figure d14 [9]
In this 130 kilometer cross section in France, a shifting seashore revealed by correlations of logged borehole samples from three sites allows in turn for the correlation of marine and land fossils between the intertonguing facies.