b22 Submarine valleys, submarine canyons < –105 m >

> The early attempts of Spencer (1903) and others to explain these features, now known as submarine canyons, as the work of rivers resulting from huge continental uplifts during the glacial period were received coolly by the geological fraternity. The idea that canyons existed on the sea floor was subjected to the same scoffing as were the contemporaneous "horseless buggies" and the "flying egg crates."
>
> —Francis P. Shepard, *Submarine Geology*, 1963.[4]

Submarine valleys

River valleys sea-flooded in from the coast are called *estuaries*. Seaward from the coast, where both these valleys *and* their interfluves are drowned, the valleys are called *submarine valleys*.

Submarine valleys are common bathometric features of continental shelves. Many are continuations of onshore valleys. They are now known to be erosional features linked, in their origin, to the Ice Age. Today 25 million cu km of glacial ice exists. During glacials (times of extensive continental ice cover) some 70 million cu km of ice was held on the land. At the last glacial maximum 21,000 BP (calendar years before present) or 18,000 YBP (*uncorrected* radiocarbon years before 1950), sealevel lowering has been estimated by Richard Peltier and Mark Tushingham to have been 105 meters.[5] As a result, continental shelves where ice did not cover them, were widely emergent. Rivers flowing across continental shelves exposed during glacials, incised their channels rapidly into the mostly unconsolidated and horizontally stratified shelf sediments.[6] To each channel, a dendritic system of tributary valleys developed outward. (These valleys, where now drowned, are submarine valleys).

In the last 2000 years, sealevel is recorded to have fluctuated little, and has risen only slightly overall (but alarmingly so in human terms, for so much is built right at the coast). In the longer view of historical geology, our familiar coastal scenery has almost entirely come to be, since mean sealevel "stabilized" about 6000 years ago (its overall rise only some 5 meters since—***Figure b22.1***). At this level, breaking waves have cut back cliffs into headlands. Sediments on, and still accumulating on, the coastal shelves are redistributed by wind-, wave-, and tide-generated currents. Swash and wash of shore-breaking waves, and surf-generated longshore currents, transport sand along coasts to build spits, bay bars, and barrier beaches.[7] Chesapeake and Delaware bays are examples of estuaries that barrier beaches now separate from the open ocean.

Submarine canyons

The western North American continental shelf is narrow today. Sediment delivered to its seaward edge (the shelf-break) can flow down the continental slope as turbidity currents (also called *density currents*) that accelerate and erode it. Deep submarine canyons result. This process is ongoing, for example, in the Gulf of the Farallones region west of San Francisco and Santa Monica Bay.[8]

The eastern North American continental shelf is wide today and submarine canyons are currently not being formed as continuations of riverine or longshore current systems. Even where elevation of land by rebound continues where glacial ice no longer loads it down, glacier melting raised sealevel far faster (at the rate of 1 meter per century) during the first 6000 years of the Holocene, flooding the wide coastal plain that was exposed during the Ice Age. During the Ice Age, continental shelves were narrow, or even absent, and down continental slopes submarine canyons were actively formed.

A legacy of the Ice Age is that submarine canyons are common erosional features of all continental slopes.[9]

The continental rise is a break in slope between continental slope and the abyssal plain, It is a depositional feature built of coalesced terrigenous submarine canyon-end fan turbidites.[10] ❑