Chapter 73

Two Uniformitarian Hypotheses

Over the years most of the many hypotheses for the origin of submarine canyons have been rejected[1], but two seem to have maintained their popularity. First, submarine canyons were formed by erosion from submarine slides on the continental slope. The landslide material was destabilized by a variety of processes unrelated to rivers or their valleys. Second, submarine canyons were formed by erosion that was caused by slope failure near the edge of the continental slope. This is usually related to a sediment source on land, like a river delta.[2,3]

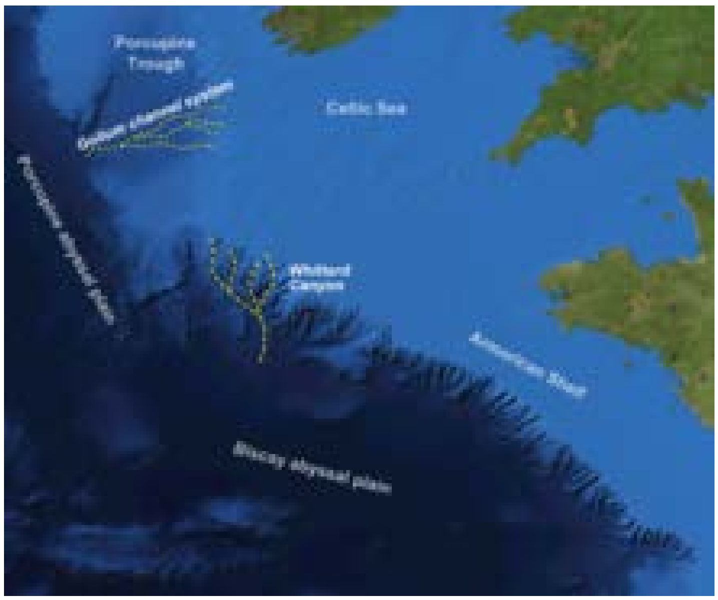

Figure 73.1. Heavily canyoned northern margin to the Biscay abyssal plain (Wikipedia). Note the numerous canyons along the continental slope.

Random Submarine Slides

In regard to the first proposal, the downslope mass movement of rock, sediment, or both is capable of eroding shallow canyons along mid-level depths of the continental slope. These canyons are usually small and are by far the most common (Figure 73.1). Continental slope canyons seem to be unconnected to the origin of the large submarine canyons that deeply indent the continental shelves, such as Monterey Canyon (see Chapter 72). It is thought in some cases a small canyon can eventually increase in size and extend to the upper slope through headward erosion. Theoretically, if the mass flow continued long enough, the canyon could erode

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[1] Shepard, F.P. and R.F. Dill, 1966. *Submarine Canyons and Other Sea Valleys*, Rand McNally & Company, Chicago, IL, p. 315..

[2] Popescu, I., G. Lericolais, N. Panin, A. Normand, C. Dinu, and E. Le Drezen, 2004. The Danube submarine canyon (Black Sea): morphology and sedimentary processes. *Marine Geology* 206:249-265.

[3] Mitchell, N.C., 2005. Interpreting long-profiles of canyons in the USA Atlantic continental slope. *Marine Geology* 214:75-99.

headward enough to extend into the upper continental shelf.[4] But, this does not appear to be the mechanism for submarine canyons.[5] If the large submarine canyons that begin close to the beach were formed in this way, we should not be able to correlate them to rivers and valleys on land. Their relationship to each other is said to be unknown or not understood by uniformitarian scientists.

Submarine Slides from Sediment Deposition

The second hypothesis associates the origin of submarine canyons with the collapse of sediments at the shelf edge. This is sometimes related to sea level lowstands, in which the rivers transport sediments to the shelf edge.[6,7] A collapse of this kind would generate a debris flow or turbidity current that likely would erode a submarine canyon. It would start at the shelf edge and grow shoreward from there. A turbidity current is an underwater flow of sediment supported by turbulence, and a debris flow is a moving mass of rock fragments and finer-grained particles (see Appendix 23). This is a plausible hypothesis, although it has problems (see below) and considered viable by uniformitarian scientists as attested to by the following quote:

> They [submarine canyons] mostly originated during sea-level lowstands by the erosion of the outer shelf and slope by retrograding landslides and dense sediment-laden flows…[8]

Waters has no doubt that turbidity currents carved submarine canyons, yet notes they would have difficulty forming meanders:

> Over millions of years, most geologists now believe turbidity currents have carved undersea canyons as surely as the Colorado River has cut the Grand Canyon … But turbidity currents alone fail to explain the canyon's particular shape, including its several sharply curving meanders.[9]

Turbidity currents are one type of mass flow where large amounts of water move bottom-hugging sediment (see Appendix 23). It is very unlikely that the Colorado River cut the Grand Canyon; there are too many problems associated with this idea.[10,11,12] So he picked the wrong analogy, but even yet we should have a degree of skepticism about this proposed origin of submarine canyons.

Problems with This Mechanism

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[4] Pratson, L.F. and B.J. Coakley, 1996. A model for the headward erosion of submarine canyons induced by downslope-eroding sediment flows. *GSA Bulletin* 108:225-234.

[5] Pratson, L.F., W.B.F. Ryan, G S. Mountain, and D.C. Twichell, 1994. Submarine canyon initiation by downslope-eroding sediment flows: evidence in late Cenozoic strata on the New Jersey continental slope. *GSA Bulletin* 106:411.

[6] Pratson *et al.*, 5 pp. 395–412.

[7] O'Leary, D.W., 1996. The timing and spatial relations of submarine canyon erosion and mass movement on the New England continental slope and rise. In, Gardner, J.V., M.E. Field, and D.C. Twichell (editors), *Geology of the United States' Seafloor: The View from GLORIA*, Cambridge University Press, New York, NY, p. 47.

[8] Lastras, G. et al., 2011. Understanding sediment dynamics of two large submarine valleys from seafloor data: Blanes andLa Fonera canyons, northwestern Mediterranean Sea. *Marine Geology* 280:21.

[9] Waters, T., 1995. The other Grand Canyon. *Earth* 4 (6):47.

[10] Austin, S.A. (editor), 1994. *Grand Canyon: Monument to Catastrophe,* Institute for Creation Research, Dallas, TX.

[11] Oard, M.J., 2010. The origin of Grand Canyon Part I: Uniformitarianism fails to explain Grand Canyon. *Creation Research Society Quarterly* 46(3):185–200.

[12] Oard, M.J. 2014 A Grand Origin for Grand Canyon (ebook). Creation Research Society, Chino Valley, AZ.

As it turns out, turbidity currents are much too weak to form submarine canyons.[13,14,15] Debris flows are a more likely mechanism, but from a uniformitarian point of view this too has problems.[16] A debris flow on land is commonly called a landslide. The problem with submarine landslides is they are not particularly erosive, mainly because they flow downslope on a cushion of water, which protects underlying sediments.[17]

Despite these difficulties, I think the hypothesis—downslope mass flow of sediments near the edge of the continental shelf—has some possibilities. Lastras and others state: "Large sediment failures are considered one of the key factors in canyon formation and evolution because they favour canyon widening and shelf incision…"[18] But hypothesis has difficulty accumulating enough sediments at the shelf edge to initiate multiple downslope flows. Rivers can transport sediments, and they may accumulate in exactly the spot needed, but many submarine canyons are not directly connected to a river or to sediment input from a river.[19] So, at best this mechanism can only apply to a subset of submarine canyons, and cannot be a general mechanism for all shelf-indenting submarine canyons.

Rivers are still important, but only indirectly, as we will see in Chapter 74. In some cases, a river can be responsible for incise a submarine canyon that already exists, since rivers can slowly deposit sediment at the head of a submarine canyon that is close to shore. This sediment can accumulate in a delta and slide down eroding the canyon, such as deduced from the Var Submarine Canyon in the northern Mediterranean Sea (see in-depth section at the end of Chapter 74).

Some canyons that lie close to shore have currents running parallel to the shoreline that transport sediment into the head of a canyon, as in Scripps and La Jolla Canyon off of San Diego, California. With time, the sediment becomes unstable and slides down the canyon. A number of observations from Scripps Canyon indicate downslope landslides are a regular occurrance.[14,20] This process modifies, deepens, and enlarges the canyon, as with the Var Submarine canyon. It is important to note this hypothesis applies to *already existing* submarine canyons. Its application to their *origin* remains in doubt.

Another problem with the localized accumulation of sediments on the shelf edge initiating a canyon is river delta sediment commonly spreads laterally, along the continental shelf.[21] Most of it does not accumulate in one location. The thin sediments spreading along the shelf tend to slowly slide seaward and trickle into the deep ocean. At best sliding could form multiple,

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[13] Shepard and Dill, Ref. 1, pp. 327-330.

[14] Shepard, F.P., 1981. Submarine canyons: multiple causes and long-time persistence. *AAPG Bulletin* 65:1,062-1,077.

[15] Shanmugam, G., 2000. 50 years of the turbidite paradigm (1950s—1990s): deep-water processes and facies models—a critical perspective. *Marine and Petroleum Geology* 17:285-342.

[16] Shepard and Dill, Ref. 1, pp. 332-335.

[17] Mulder, T. and J. Alexander, 2001. The physical character of subaqueous sedimentary density flows and their deposits. *Sedimentology* 48:269-299.

[18] Lastras, G., R.G. Arzola, D.G. Masson, R.B. Wynn, V.A.I. Huvenne, V. Hühnerbach, and M. Canals, 2009. Geomorphology and sedimentary features in the Central Portuguese submarine canyons, Western Iberian margin. *Geomorphology* 103:324.

[19] Lastras *et al.*, Ref. 18, p. 326.

[20] Shepard, F.P. and R.F. Dill, 1966. *Submarine Canyons and Other Sea Valleys*, Rand McNally & Company, Chicago, IL.

[21] Baztan, J., S. Berné, J.-L. Olivet, M. Rabineau, D. Aslanian, M. Gaudin, J.-P. Réhault, and M. Canals, 2005. Axial incision: the key to understand submarine canyon evolution (in the western Gulf of Lion). *Marine and Petroleum Geology* 22:806.

shallow submarine canyons but not one giant submarine canyon.

Example of the Eel River "Delta" Northern California

A study was done of mud deposited in the ocean from the Eel River in northern California. It concluded the sediment at first was deposited by rivers on the inner continental shelf. Then it quickly spread seaward along the shelf , being slowly transported downslope to the outer shelf.[22,23] From the outer shelf, it continued to creep down the continental slope or was transported to the head of the Eel Submarine Canyon.[24,25] The route down a submarine canyon of course would be faster. Either way the river sediments did not accumulate in one area. They spread horizontally along the continental shelf and gradually crept down the continental slope into the deep sea. So in thinking about the origin of the submarine canyon and not its subsequent modification, it is unlikely that river sediments would become thick enough in any one place to initiate multiple landslides to form a large submarine canyon.

Most Deltas Do Not Have Submarine Canyons

Of course, thick sediments do accumulate in river deltas where sedimentation sometimes exceeds the ability of the longshore currents to disperse them[26] As a result, it is not surprising some large deltas like the Congo Delta have submarine canyons. The Congo Submarine Canyon begins in the river and runs 500 miles (800 km) westward down into the deep sea (see Figure 70.2). At its deepest, the wall of the canyon is about 4,000 feet (1,200 m) deep. Most deltas do not possess a submarine canyon of note but show a variety of linear channels from multiple downslope mass movements along the edge of the delta. The Mississippi River Delta is a good example of this.[27]

The Origin of Submarine Canyons Unknown

Prior to marine exploration, geologists were skeptical of the very existence of submarine canyons. They considered them "figments of the imagination." This was due to a strong uniformitarian bias against catastrophes, which submarine canyons implied:

> However, geologists soon became very skeptical of this idea and their doubts extended even to the actual existence of submarine canyons. When an observation offends one's preconceived ideas, it is easy to dismiss it … In those days, canyon studies were not easy to make, and the spectre of world-wide drowned river canyons thousands of feet deep was devastating to those with a firm belief in the orderly processes of geology [uniformitarianism]. It smacked of the outmoded ideas of catastrophism.[28]

So, submarine canyons really should not exist if uniformitarianism were true for millions of

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[22] Traykovski, P., W.G. Geyer, J.D. Irish, and J.F. Lynch, 2000. The role of wave-induced density-driven fluid mud flows for cross-shelf transport on the Eel River continental shelf. *Continental Shelf Research* 20:2,113-2,140.
[23] Wheatcroft, R.A., 2000. Ocean flood sedimentation: a new perspective. *Continental Shelf Research* 20:2,059-2,066.
[24] Puig, P., A.S. Ogston, B.L. Mullenbach, C.A. Nittrouer, and R.W. Sternberg, 2003. Shelf-to-canyon sediment transport processes on the Eel continental margin (Northern California). *Marine Geology* 193:129-149.
[25] Mullenbach, B.L., C.A. Nittrouer, P. Puig, and D.L. Orange, 2004. Sediment deposition in a modern submarine canyon: Eel Canyon, Northern California. *Marine Geology* 211:101-119.
[26] Kennett, J., 1982. *Marine Geology*, Prentice-Hall, Englewood Cliffs, NJ, pp. 294-295.
[27] Prior, D.B. and J.M. Coleman, 1982. Active slides and flows in underconsolidated marine sediments on the slopes of the Mississippi delta. In, Saxov, S and J.K. Nieuwenhuis (editors), *Marine Slides and Other Mass Movements*, Plenum Press, New York, NY, pp. 21-49.
[28] Shepard and Dill, Ref. 1, pp. 2-3.

years.

Submarine canyons were first discovered in the late 1800s. After a while uniformitarian scientists could no longer deny their existence. Even as submarine canyons became better known, they continued to puzzle geologists. Von Der Borch stated:

> Submarine canyons have long been a geological enigma. Their possible origin and age of formation have been subjects of controversy since their recognition as long ago as 1893.[29]

Nagel and others reinforced his observation:

> The origin and evolution of submarine canyons has been a controversial topic in marine geology for many decades and a variety of possible mechanisms for canyon cutting have been proposed (Shepard and Dill, 1966).[30]

Mulder and others concur:

> The cause of canyon formation and persistence is a key question, as canyons are the main pathways for sediments from continent to ocean.[31]

Baztan and colleagues write: "However, the origin of submarine canyons remains a matter of speculation."[21] Lastras and others write: "In spite of this large effort, a general world-wide accepted valid theoretical context of the location, evolution and activity of submarine canyons is not yet available."[32]

Consequently, submarine canyons are another one of those many features of geomorphology that are difficult for uniformitarian geologists to explain. Even after decades of intensive research, Waters noted the origin of Monterey Canyon was not yet known.[33]

The origin of huge submarine fans, the largest sedimentary feature on earth,[34] is also a puzzle. Most of these submarine fans are located in the deep sea at the mouths of submarine canyons. As more information becomes available, earlier hypotheses are demonstrated to be inaccurate:

> No study to date, however, has integrated all available data to document the stratigraphic development of the fan and its feeding systems, and as a result, none of the existing depositional models for Monterey Fan history are accurate.[35]

Among the many observations that need to be included in the study are: (1) canyons are just as commonly cut in igneous rock as sedimentary rock and interestingly, with no difference in depth; (2) most canyons have winding courses; (3) many tributary canyons enter the main canyon as hanging valleys; (4) the slope at the head of the canyon is steeper than downslope; and (5) most shelf-indenting canyons are located off river valleys.[36] I am convinced that after all of the data is gathered catastrophism is the best explanation for how these features came to be.

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[29] Von Der Borch, C.C., 1968. Southern Australian submarine canyons: their distribution and ages. *Marine Geology* 6:267.

[30] Nagel, D.K., H.T. Mullins, and H.G. Greene, 1986. Ascension Submarine Canyon, California—evolution of a multi-head canyon system along a strike-slip continental margin. *Marine Geology* 73:286.

[31] Mulder, T. *et al.*, 2004. Understanding continent-ocean sediment transfer. *EOS, Transactions, American Geophysical Union* 85(27):261.

[32] Lastras *et al.*, Ref. 18, p. 311.

[33] Waters, Ref. 9, pp. 46-47.

[34] Peakall, J., I.A. Kane, D.G. Masson, G. Keevil, W. McCaffrey, and R. Corney, 2012. Global (latitudinal) variation in submarine channel sinuosity. *Geology* 40:11.

[35] Fildani, A. and N. Normark, 2004. Late Quaternary evolution of cannel and lobe complexes of Monterey Fan. *Marine Geology* 206:205.

[36] Shepard and Dill, Ref. 1, pp. 312-315.