Most cosmic bodies impacting the Earth fall into seas and oceans, which cover more than two-thirds of the Earth’s surface. However, among more than 150 craters discovered on the Earth, only 15–20 found recently were formed as a result of marine target impacts (Ormö and Lindström 2000). The deficit of underwater craters is explained by the relative youth of a typical ocean floor (<150–180 Ma), insufficient exploration of the sea/ocean floor, and specific features of the underwater cratering process. Most of the known underwater craters were formed in shallow seas, where the water depth is comparable with an impactor size. Eltanin (Gersonde et al. 1997) is the only presently known impact structure formed due to impact into a deep (~4 km) ocean.

The process of cratering of marine target impacts has been poorly investigated; however, relations obtained for continental craters are commonly used to estimate the parameters of underwater craters. A small number of numerical simulations were performed for the first stage of marine impacts of very large projectiles (~10 km), which are of interest from the viewpoint of impact-induced mass extinctions of biota (O’Keefe and Ahrens 1982b; Roddy et al. 1987). However, these simulations gave neither the shape of a final crater nor the parameters of generated tsunami waves. Laboratory experiments (Gault and Sonnet 1982) and detailed numerical simulations (Artemieva and Shuvalov 2002) made it possible to determine the critical sea depth at which an underwater crater is formed at the sea floor and where shock-modified material can be found. A number of works (Adushkin and Nemchinov 1994; Hills et al. 1994; Nemtchinov et al. 1996) used the estimates based on nuclear explosion data and the numerical modeling of the impact initial phase to study tsunami generation caused by the impact of a comet into an ocean 4 km in depth.
Ormö and Lindström (2000) presented a hypothesis that marine impacts can generate concentric craters with a relatively small depression on the top of a solid crystalline basement, which is located in the center of a larger shallow crater formed in low-strength sedimentary rocks. Such structures are observed, for example, on the Moon (Quaide and Oberbeck 1968), where solid rocks are covered with a layer of regolith. The diameter ratio for the outer and inner craters can reach 5:10. However, preliminary calculations (Shuvalov 2000) have shown that this ratio cannot exceed 2:3 for the fall of cosmic bodies into terrestrial seas, and it is likely that the real ratio is even less.

One more characteristic feature of underwater craters is radial channels (gullies) around the central depression. Such channels (up to 100 m in depth, 1 km in width, and several kilometers in length) are clearly seen around the crater Lockne (Ormö and Lindström 2000) and Kamensk (Movshovich and Milyavskii 1990). The formation of gullies is accounted for by erosion of the crater floor while water is filling the crater (Dalwigk and Ormö 2001). A theoretical model of this process has not yet been developed. It is not clear how the expected effect depends on the ocean depth and why well-pronounced gullies have not been found around other underwater craters. The morphology of underwater craters has hardly been studied so far.

The fall of an asteroid into a water basin is a typical example of a high-velocity impact into a stratified target. At least three layers can be distinguished here: water, low-strength sedimentary rocks, and a crystalline basement. A qualitative description of crater formation in the stratified target was given by Quaide and Oberbeck (1968). They investigated experimentally the impact (at a speed of 1–7 km·s$^{-1}$) of cylindrical and spherical bodies (glass, lexan, aluminum), 4–8 mm in size, into a target composed of a sand layer covering a stronger material (sand glued with epoxide resin). Various craters (parabolic, flat-bottomed, and concentric) were generated at different ratios between the impactor diameter and the sand layer thickness. However, these results cannot be used quite correctly to explain the mechanism of formation of underwater craters on the Earth, since Quaide and Oberbeck (1968) investigated small strength-dominated craters with morphology and relative sizes differing from those for large gravitational craters (Melosh 1989).

The existing results of experimental and theoretical studies show that the cratering process is largely determined by parameter $d/H$, where $d$ is the impactor diameter and $H$ is the sea depth. When $d/H < 0.1$, no underwater crater is formed at all (Gault and Sonnet 1982; Artemieva and Shuvalov 2002). When $0.2 < H < 2$, a water layer significantly influences the cratering process, sizes, and morphology of the resulting crater (Shuvalov 2000). Finally, when $d > 2H$, the water column has almost no effect on the crater-forming flow (Shuvalov 2000). However, even in this case the structure and morphology of the resulting crater can differ from those of similar craters on land. This difference is explained by the different petrophysical properties of the target as well as by the erosion of the surface of the crater while it is being filled with water (Ormö and Lindström 2000).