Marine Target Impact Structures and Petroleum Exploration

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Marine target impact structures are generally circular deformation features with a distinctive set of physical characteristics that arise from a cosmic impact event in which there is substantial kinetic energy transferred from a hypervelocity projectile. The projectile's impact causes an excavation flow that encompasses the overlying layer of sea water, the sedimentary deposits of the sea bed, and frequently also the underlying basement. There are a few marine-target craters known to host hydrocarbon deposits, for instance two carbonate-target craters: 13-km Ames crater (Oklahoma) and the well-known, 170-km Chicxulub crater. In this paper, we will use another well-established marine target crater, the Late Cretaceous Wetumpka impact structure in Alabama, as an example. Wetumpka has no hydrocarbons but is representative of siliciclastic-dominated marine target impact structures wherein the crystalline basement is also involved in the impact deformation. The well-exposed Wetumpka impact structure is characterized by a wide, horseshoe-shaped crystalline rim terrain, an interior region of broken and disturbed sedimentary formations, and a southwestern, extra-crater terrain composed of structurally disturbed target formations. The extant crater rim, which is a distinctly positive topographic feature, spans 270 degrees of arc and is open on the southwest (the same side as the structurally disturbed terrain). The northwest-southeast diameter of the crystalline rim is approximately 5 km. As with most marine target impacts, at Wetumpka, the energetic return of displaced sea water had a profound effect upon the stratigraphy and physical properties of the crater filling. In particular, there is a sporadically preserved upper, fine-grained, crater interior formation, which lies on top of a more deeply buried, porous and permeable structure-filling sand and breccia unit. This sand and breccia fills a deep bowl-shaped depression within the impact-fractured crystalline bedrock of the area. Porosity and permeability are on average an order of magnitude higher in the structure-filling sand and breccia unit, as compared to the overlying fine-grained unit. Hence, a natural trap situation has been created within the crater bowl by the return of sea water, which is largely responsible for the emplacement of the finer grained upper unit. In addition, fractures within the underlying crystalline bedrock provide porosity conduits to the porous and permeable sands and breccias.