Multiscale analysis of the geomorphological characters of a guyot on the Caroline Ridge in West Pacific

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Many seamounts in the deep sea have been found and surveyed in detail in recent decades of years. However, these seamounts are mostly described qualitatively or with little quantitative analysis, which counts against deep understanding of the dynamic processes of the seafloor. Here, a recently-surveyed guyot on the Caroline ridge in West Pacific is reported and its geomorphology is documented in detail based on the high-resolution Digital Elevation Models (DEMs). Multifractal Detrended Fluctuation Analysis (MFDFA) is firstly applied on the bathymetric data to investigate the multifractal features, and the cause of multifractality is also verified by analyzing shuffled and surrogate data. The shape of the multifractal spectrum is depicted by the width of the spectrum (W), the maximum singularity strength (α₀) and the degree of asymmetry (B). To examine distinctions between submarine seamounts and subaerial volcanic structures, the same method and statistical comparison have also been applied on DEMs of other seamounts adjoining the guyot, the SRTM 90m DEMs of 50 subaerial stratovolcanoes and the Mars MGS MOLA-MEX HRSC Blended 200m DEMs of 5 Martian volcanoes. In the guyot area, geomorphological units of the guyot can be recognized and classified into large-scale volcanic structures and small-scale erosive-depositional landforms. The result shows that the topography of the guyot has multifractal features and the multifractal strength (Δh) differs spatially. Multifractality of the seafloor with the flat guyot top is mostly caused by the broad probability density function of the values of bathymetric data, while multifractality of the seafloor with highly-correlated small-scale landscapes (gullies and faults) by different long-range correlations of the small and large fluctuations. The guyot and other landforms with flat tops around are featured by higher maximum singularity strength (α₀). Areas with widely-distributed small-scale landforms and intense fluctuations in curvature values tend to have negative degrees of asymmetry (B). Moreover, two-sample unequal-variance t-test results show that Hurst exponents (H) and the multifractal strength (Δh) of seamounts are generally lower than those of earth and Martian subaerial volcanoes, which implies that seamounts may have distinct fractal behaviors and multifractal features compared to their subaerial counterparts. The study presents a case of quantifying geomorphological characters and multiscale behaviors of seamounts in the deep-sea area, which could encourage more explorations for the morphologies and processes of the analogous structures in submarine, terrestrial or even planetary environments. Nevertheless, more detailed and comparative works are still needed to be done.