Positive-relief carbonate pavements on the central Nile deep-sea fan : gas hydrate blisters or carbonate-filled pockmarks?

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Résumé

The Nile deep-sea fan is rich in fluid vents, including a Central Province of acoustically reflective patches that correspond at seafloor to fractured carbonate pavements hosting chemosynthetic ecosystems. The backscatter patches (BPs) have been referred to as pockmarks, but several studies have noted positive relief. We examine the BPs by integrating older multibeam datasets (50-100 m DTMs) with sonar imagery of higher resolution acquired in 2010 (APINIL campaign) using a hull-mounted multibeam (30 kHz, 10-25 m DTMs) and a deep-towed sidescan (180 kHz, 1.5 m pixels. We recognise at least 450 BPs in water depths of 1550-2700 m, sub-circular to elongate and 70-600 m wide, almost all of positive relief up to 7 m. The BPs vary in backscatter intensity on both 30 kHz and 180 kHz imagery, and differ in character between them. We attribute this to varying sediment penetration by the two systems, which respectively integrate impedance contrasts to depths of 3 m and 0.1 m. At local deposition rates, this corresponds to timescales of 5-100 ka. In the absence of erosion, backscatter variations and fractures observed on 180 kHz imagery suggest shifting patterns of carbonate growth and breakage over the last 5 ka. Four water column gas flares observed in 2010 in high backscatter areas suggest on-going carbonate cementation. Previous studies of the area indicate downward growth of carbonate pavements, at rates much less than those of burial, and it has been proposed that self-sealing drives the outward growth of broad pavements. However, such a process does not generate stress fields and should result in buried lenses of zero relief. We propose that the elevated and fractured seafloor carbonates we observed as BPs record interactions with underlying gas hydrates. One possibility is that BPs are 'hydrate blisters', comprising thin carbonates above growing gas hydrate lenses; however, the lack of deflated features (hydrate pockmarks) is puzzling. Another possibility is that fracturing in response to hydrate formation and dissolution allows fluid migration through recurrently buried pavements, resulting in the upward growth of mixed carbonate-sediment mounds that overfill hydrate pockmarks. We intend to test

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