Large slump structures in the Macumber Formation, basal Windsor Group, Ingonish area, northeastern Cape Breton Island

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Are folds in the basal Windsor Group at northeastern Cape Breton Island due to tectonic forces of middle to late Carboniferous age (as they may be in western Cape Breton), or are they due to syndepositional slumping? The Gays River Formation outcrops as an almost horizontal sheet for 1100 m along the coast of Bear Cove near Ingonish, northeastern Cape Breton. The formation consists of two lithologic zones, in upward succession: (1) carbonaceous, vuggy, black limestone (0.5 m); and (2) thinly to very thinly stratified, vuggy, peloidal dolomudstone (up to 18 m). The Gays River Formation overlies, permeable, pebbly, feldspathic sandstone (Horton Group) of braided-stream facies. Blooms of botryoidal native sulphur and malachite stain exposure surfaces. The dolomudstone is vuggy (cm-sized vugs make up 40% by volume); channels leading upward to foundered spring pits and sand volcanoes abound; mm-sized vugs create a frothy appearance and upper parts of the layer have metre-size, discordant, vuggy pipes. Micro-breccia occurs in other areas but macro-brecciation and cleavage are absent. The dolomudstone has laterally extensive, internally folded sheets arranged in stratigraphic sequence. Individual sheets intercalate either with undisturbed strata or with other deformed sheets. Folds in underlying sheets are unaffected by those in overlying sheets and the facing direction of folds differs between deformed sheets. The folds are tongue or tear-drop shaped, recumbent, isoclinal antiforms ranging in size from metres to several decametres. They form toe-like bodies with vertical separation surfaces, i.e., synforms are absent. In plan sections, folds are fan shaped, with hinges curved through 180 degrees. Vergence varies, with larger folds mainly facing south whereas smaller ones are more variable. The folding rotated lensoid barite-lined vugs up to 20 cm in diameter.

The folds in the Ingonish area are syndepositional slump structures. At the time of deposition, the carbonate ooze was heavily charged with gases. Three sources of the gas were: (1) H_2S and/or SO_2 rising through the permeable Horton Group sandstones from underlying igneous rocks (S-oxidizing bacteria now precipitate the native sulphur); (2) bacterial SO_2 reduction of organic matter in the basal carbonaceous limestone; and/or (3) H_2S and/or CO_2 released as byproducts of SO_4- reducing bacteria that precipitated the peloidal carbonate ooze. Hydrodynamic shock, probably due to earthquakes from boundary faults, increased pore-fluid pressure and released large quantities of gas, creating channels leading to mud volcanoes, and parvoids, bubbles, and spouting vents. The liquefied near-surface layers oozed down a shallowly southward inclined, basin floor. Steep flanks of large, more viscous flows failed, creating divergent, smaller, watery slumps. Refolding of underlying folded layers did not occur because the earlier folding bled prerequisite, excess pore-fluid pressures. The folds are not tectonic.