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Polymorphic authigenic carbonates and foraminifera taphonomical characteristics of a paleoseep, Southwestern Taiwan

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Several polymorphic authigenic carbonate concretions (ACC) were preserved in the Pliocene Yenshuiken Formation of SW Taiwan foreland sequence. Carbon isotopic signatures and morphology of these carbonates and associated chemosymbiotic bivalve fossils indicated their methane seep origin. Foraminiferal fossil assemblages in host rocks represented distinctive differentiation in short distance ($\sim$40 cm) away from some large ACCs, revealed that the taphonomic characteristics of foraminiferal assemblages were directly influenced by methane emission intensity within the paleoseep.

There are three modes of ACCs: (I) *Massive brecciated blocks* (MBBs; δ^{13}C: -49.6$\sim$-38.2‰ averagely -44.2‰); (II) *Giant Chimneys* (GCs; δ^{13}C: -43.1$\sim$-17.7‰ averagely -32.9‰); and (III) *Slender pipe networks* (SPNs; δ^{13}C: -43.5$\sim$5.9‰ averagely -25.9‰). Relatively ^{13}C-depleted MBBs and GCs locate in the core area of the fossil pockmark, whereas SPNs (with wider δ^{13}C ranges) were widespread within the paleoseep. Comparing to the non-seep controls in the Yenshuiken Fm., muddy host rocks that were $<$30 cm around MBBs yield low $CaCO_3$ contents ($<$1%), low foraminiferal abundances ($<$6.3 individual per gram of sediments), high percentages of agglutinated benthic foraminifera ($>$98%), and almost absence of calcareous foraminifera (both benthic and planktonic); however, host rocks that were $>$30 cm away from MBBs yield "normal marine" assemblages (high foraminiferal abundance: 20.7-77.5 individuals/per gram of sediments; low agglutinated foraminifera percentages: $<$13.4%; fair $CaCO_3$ contents: 3.4-7.8%). Host rocks that were $<$80 cm around GCs also yield abnormal assemblages, whereas those were $>$80cm away from GCs yield normal assemblages. Host rocks around and between SPNs yield consistent characteristics to control sites.

Absence of calcareous tests of foraminiferal fossils is due to pore water acidification within the taphonomically active zone (TAZ), which is triggered and accelerated by anaerobic oxidation of methane (AOM) in the methane seep environments. We suggest that foraminiferal assemblages can be influenced by methane seep activities, therefore they can reflect and record geochemical interface (e.g. TAZ; sulfate-methane transition zone (SMTZ) where AOM occurs) shifting within paleoseeps.