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Jiulong methane reef: First direct evidence of methane seepage in the South China Sea

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An area of methane seepage in the South China Sea with enormous build-ups of authigenic carbonate, named “Jiulong methane reef”, was discovered during RV Sonne cruise 177 in 2004 and reported here for the first time. The area is located on the northern continental slop in water depths between 500 and 800m and covers about 430 km^2. Observation from TV-guided instruments revealed that chemoherm edifices stand above the seafloor, abundant carbonate chimneys occur throughout, that slabs, blocks are lying or protruding from sediments, and shell debris are scattered or distributed in patches on the sea floor. Numerous TV-guided grabs were deployed and hundreds of carbonate samples were retrieved as well as shell debris of chemoauthotrophic bivalves such as *Calyptogena* sp. and *Acharax* sp. Basically the carbonates recovered are comparable to cold seep carbonates discovered on continental margins world wide, e.g. Costa Rica margin (Han et al., 2004), Cascadia margin (Kulm et al., 1986; Bohrmann et al., 1988), Gulf of Mexico (Aharon et al., 1992) and other well-known sites but also have a unique characteristic, namely high-Mg calcites, to our knowledge hitherto unknown. Lithologically, most of the carbonate samples in South China Sea are micritic concretion containing detrital grains, a few are highly

brecciated carbonates with aragonite layer linings of fractures and elongated voids. Mineralogically, the high-Mg calcites (HMC) vary over a wide range with $MgCO_3$ contents between 8 to 37.5 mol%, aragonite, low-Mg calcite and minor protodolomite are also present. All of the carbonates are strongly depleted in $\delta^{13}C$ over a range from –35.70 to –57.55 ‰ PDB and enriched in $\delta^{18}O$ (+1.7 to +5.3 ‰ PDB). All characteristics indicate that the carbonates are derived from biogenic methane, when fluids are transported from below into the sulfate reduction zone and exit from the seafloor as cold seeps. The maximum content of 37.5 mol % MgCO3 among the dominant phases is an exception to the other cold vent carbonates discovered in the world oceans; their remarkable composition could be related to their microbial mediated formation. Our results show that the newly discovered authigenic carbonates from South China Sea provide information on the fate of methane escaping from the seafloor and represent an archive of fluid venting as well as on the evolution of the seafloor environment.