**Supplementary Table S1**. A selection of “modern” (seabed) and ancient conduit carbonate concretions and/or seep carbonate or limestone examples of MDAC (methane-derived authigenic carbonate) from the literature (author publications arranged chronologically), including their age, main MDAC morphologies and mineralogies, and range of carbonate stable carbon (δ13C) and oxygen (δ18O) isotope values. Interpreted MDAC origins based mainly on their isotope compositions. The last column is a generalised assignment of the main MDAC types for each example into the inferred environmental settings used in this paper (i.e. seep limestone, formed at the seafloor; conduit concretions, formed below the seafloor; or both). AOM = anaerobic oxidation of methane. HMC = high-Mg calcite. LMC = low-Mg calcite. NA = not addressed.

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| **Authors** | **Location** | **Age** | **Main MDAC morphology** | **Mineralogy** | **δ13C ‰ VPDB** | **δ13C interpretation** | **δ18O ‰ VPDB** | **δ18O interpretation** | **Inferred main MDAC setting** |
| Hovland et al. (1985, 1987) | North Sea | Seabed (pock-marks) | Slabs/blocks  Crusts  Cements | Arag (botry)  HMC | -61.1 to -52.2 | Oxidation of thermogenic methane gas | +1.9 to +4.7 | Pptn from cold (7oC) bottom waters | Seep limestone |
| Beauchamp & Savard (1992) | Canadian Arctic | Cret | Fossiliferous mounds (+ ppts) | Calcite | -50 to -35 | AOM (+ aerobic oxidation of CH4) | -4 to +2 | Ambient marine pore waters | Seep limestone |
| Jörgensen  (1992) | Kattegat, Denmark | Seabed | Pillars, slabs, blocks, pavements | Dolomite  HMC & aragonite | -61 to -34  -57 to -26 | AOM  AOM | +3.2 to +4.1  +0.4 to +2.8 | NA  Marine | Conduit concretions, exhumed |
| Clari et al. (1994) | Marmorito,  Piedmont,  N Italy | Mio | *Lucina* lst + ppts | Calcite | -30.4 to -12 | AOM (+ oxic dissoln) + mixing bicarb | +0.1 to +4.9 | Low To pore fluids | Seep limestone |
| Orpin (1997) | Otago shelf, NZ | Seabed | Chimneys | Dolomite  Dolomite | -12.8 to -4.9  +16.3 | Degradn org mat  Resid C methano | +4.9 to +5.4  +1.8 | Marine  Marine | Conduit concretions, exhumed |
| Bohrmann et al. (1998); Teichert et al. (2005) | Hydrate Ridge, Cascadia margin | Near below seabed | Dissem. xtals  Layers (after spongy hydrate (clathrite) | Arag (yellow, botry, isopa) in cavities in gas hydrates  (HMC) | -54 to -40 | Consistent with a methane source | +3.3 to +4.9 | Gas hydrate dissociation | Seep limestone |
| Sassen et al. (1998) | Gulf of Mexico | Seabed | NA | NA | -24 to -19 | Bacterial oxidn of hydrate-bound methane | NA | NA | NA |
| Stakes et al. (1999) | Monterey Bay, California | Seabed | Chimneys, pavements, slabs | Dolomite  HMC | -56.0 to -46.4  -35.3 to -32.4 | AOM | +3.5 to +5.7  +6.6 to +6.7 | Mix marine & meteoric waters | Conduit concretions, exhumed |

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| **Authors** | **Location** | **Age** | **Main MDAC morphology** | **Mineralogy** | **δ13C ‰ VPDB** | **δ13C interpretation** | **δ18O ‰ VPDB** | **δ18O interpretation** | **Inferred main MDAC setting** |
| Aiello et al. (2001) | Monterey Bay, California | Mio | Pipes, pavements, lenses | Calcite | -9 to -4 | AOM or resid C from methano | -1.2 to +1.9 | Marine, low To fluids | Conduit concretions |
| Greinert et al. (2001) | Hydrate Ridge | Seabed & near below | Chemoherm complexes | Aragonite  (HMC)  (LMC, dolo) | -55.2 to -38.0 | Decomp. org. mat. via sulphate reduction | +3.0 to +12.2 | Gas hydrate dissociation | Seep limestone |
| Pierre et al. (2002) ; Pierre & Rouchy (2004) | Lorca Basin,  Mediter-ranean | Late Mio | Nodules, layers | Dolomite | -26 to +10  (most >0) | Residual C from methanogenesis | -2 to +5 | Hydrate dissociation | Nodular concretions |
| Díaz-del-Río et al. (2003) | Gulf of Cadiz, Portugal | Seabed | Diverse chimney types | Fe-dolomite, ankerite, calcite | -40 to -20 | AOM | +0.5 to +6 | Episodic hydrate dissociation | Conduit concretions,  exhumed |
| Mazzini et al. (2003) | Gryphon Field, North Sea | Tert | Tubes, dykes | Calcite | -35.5 to -18 | AOM | -2.9 to -0.1 | Shallow burial, mixed marine & meteoric | Conduit concretions |
| Schwartz et al. (2003) | Panoche Hills, California | Cret-Pal | Intrusions + fossiliferous slabs/blocks | HMC  (dolomite, calcite) | -14 to -9 | Mixing thermo + bio CH4 oxid + marine bicarb | -1.5 to +0.5 | Marine | Both |
| Boetius & Suess (2004) | Hydrate Ridge | Seabed | Chemoherms Chimneys | Aragonite  HMC | -65 to -38 | AOM for sulphide production & carbonate pptn | NA | Hydrates involved | Seep limestone |
| Clari et al. (2004) | Monfer-rato, Italy | Mio | Pipes, slabs, blocks, ff lsts | Dolomite | -25 to -10 | Mixing AOM + marine bicarb | +4 to +8 | Hydrate dissociation | Both, but includes  olistostromal  examples |
| Conti et al. (2004) | Nth Apennines, Italy | Mid Mio | Chemoherms  Lenses  (brecciated, reworking) | Calcite (Dolomite) | -36 to -3.6 | AOM + mixing DIC with marine pore waters | -4 to +1.5 | NA; infer hydrate dissociation | Both, but includes olistostromal examples |
| Majima et al. (2005) | Japan | Cret to Holo | Nodular & discontin to mound-like (Some pipes) | Aragonite  Calcite  Dolomite | -60 to -20 | AOM + mixing marine | -10 to +5 | Mainly NA, but refer to hydrate dissociation | Seep limestone |
| **Authors** | **Location** | **Age** | **Main MDAC morphology** | **Mineralogy** | **δ13C ‰ VPDB** | **δ13C interpretation** | **δ18O ‰ VPDB** | **δ18O interpretation** | **Inferred main MDAC setting** |
| De Boever et al. (2006) | Varna, Bulgaria | Early Eo | Large chimneys | Calcite | -43 to -8 | CH4 derived C + mixing marine bicarb or resid C | -8 to -1 | Marine to elev To; some high fluid flow rates | Conduit concretions |
| Bojanowski (2007) | Carpathi-ans, Poland | Oligo | Lenticular mounds | Calcite | -39 to -16 | AOM | NA | NA, but infer gas hydrates | Seep limestone |
| Judd et al. (2007) | Irish Sea | Seabed | Mounds (5-10 m high)  Boulders, ff | Arag (acic)  (HMC)  Framb pyrite | -46 to -41 | MDAC from AOM | NA | NA | Seep limestone |
| Clari et al. (2009) | Monfer-rato, NW Italy | Oligo-Mio | *Lucina* lsts, blocks, big concretions, veins | Dolomite  Calcite | -45 to -10 | AOM + mixing DIC in pore waters | 0 to +8 | Hydrate dissociation, possible clay dehydration | Seep limestone, some reworked |
| Campbell et al. (2010) | East Coast Basin, NZ | Just beneath seabed | Nodular to irregular layers | Aragonite  (HMC) | -50.3 to -0.6 | AOM | +0.8 to +3.2 | Gas hydrate dissociation and/or clay dehydration | Seep limestone |
| Nyman et al. (2010) | Cape Turnagain, NZ | Late Mio | Pipe  Pipe/bulbous | Calcite  Dolomite | -21 to +12  -0.5 to +13 | Extensive AOM  and/or mixing microbial CH4  & methanogenic CO2 | -1 to +5  +1.8 to +5.5 | Dissociation of gas hydrates | Conduit concretions |
| Nyman & Nelson (2011) | Taranaki Basin, NZ | Late Mio | Pipe  Bulbous  Conduit fill | Calcite  Dolomite  Calcite | -40 to -25  -10 to +10  -1 to +5 | AOM  Methanogenic CO2 and/or signif. CH4 oxidn | -2 to +3  +0.2 to +5  -6 to -1 | Episodes of gas hydrate fm & dissociation | Conduit concretions |
| Pierre et al. (2012) | SW Africa | Seabed & near below | Carb crusts  Chemo ff | HMC  Aragonite | -61 to -40 | Variable rates of AOM | +2.4 to +6.2 | Bottom water To ± hydrate dissociation | Seep limestone |
| Kiel et al. (2013) | East Cape region, NZ | Cret | Fenestrae and vug fills | Calcite varieties | -29.2 to +7.1 | AOM + marine carbonate | -15 to 0 | Marine pore water to burial diagenesis | Seep limestone |
| Angeletti et al. (2015) | SE Adriatic Sea | Seabed Pleist | Pipe/tubular  concretions | Dolomite  (calcite) | -30.8 to +2.5 | Degradation of seeping H/Cs, AOM | +3.0 to +6.0 | Low To ambient fluids | Conduit concretions |

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| **Authors** | **Location** | **Age** | **Main MDAC morphology** | **Mineralogy** | **δ13C ‰ VPDB** | **δ13C interpretation** | **δ18O ‰ VPDB** | **δ18O interpretation** | **Inferred main MDAC setting** |
| Blumen-berg et al. (2015) | Nth Apennines, Italy | Plio-Pleist | Pipe/tubular  concretions | Dolomite, ankerite,  kutnohorite | -26.4 to -13.3 | SO4 reduction using alkaline fluids, ?AOM | +4.0 to +5.6 | NA | Conduit concretions |
| Cau et al. (2015) | Stirone R,  Apennines,  Italy | Plio | Chimneys  Chemoherms  Lst breccia | Dolomite  HMC + LMC | -37.5 to -17.6 | AOM | +2.2 to +5.9 | Hydrate dissociation or low temps | Both |
| Cavagna et al. (2015) | Piedmont Basin, NW Italy | Late Mio | Cylindrical & macro-concretions,  *Lucina* lsts | Dolomite | -34.3 to -9.7 | AOM | +4 to +8 | Possibly hydrate dissociation | Both, some reworked limestone |
| Ge et al.  (2015) | S China Sea  NE Taiwan | Seabed  Plio | Chimneys  & crusts  Chimneys | Dolomite,  aragonite, HMC | -57.6 to -24.0 | AOM from biogenic source | NA | NA | Conduit concretions |
| Little et al. (2015) | Antarctica | Late Cret | Carb bodies (chemo ff)  Concretions  Burrows | Complex calcite cement fabrics | -58 to -25 | AOM | -8.3 to +2.1 | NA | Both,  including burrow fed conduits |
| Oppo et al. (2015) | Enza River, Nth Apennines,  Italy | Pleist | Chimneys  Slabs | Dolomite | -28.6 to -8.6 | AOM from biogenic source in SO4-depleted fluids + connate | +4.4 to +6.2 | Ambient fluids | Conduit and slabby concretions |
| Reitner et al. (2015) | Vocontian Basin, France | Early Cret | Pipe/sausage concretions | Calcite  (Fe calcite) | -25 to +1 | AOM + SO4  reduction | -5 to 0 | Marine, increasing fluid Tos | Conduit concretions (burrow fed) |
| Wiese et al. (2015) | Basque Country, N Spain | Early Cret | Pipe concretions in burrows | ?Calcite  (several phases) | -30.8 to -3.2 | AOM dominates | -8 to -11  mainly | NA | Conduit concretions (burrow fed) |
| Zwicker et al. (2015) | Washing-ton State, USA | Oligo | Pipe concretions in burrows | Aragonite  Calcite  Matrix micrite | -50.6 to -41.2  -2.3 to +3.9  -41 to -19 | AOM early fill  Methano late fill  AOM | +0.8 to +1.5  -6.5 to -4  -4 to 0 | Marine  Increasing To during burial | Both  (burrow fed) |
| Nelson et al. (2017) | East Cape, NZ | Late Mio | Doughnut  (Pipe) | Dolomite  Dolomite | +6 to +9 | Extensive AOM | +2 to +6 | Dissociation of gas hydrates | Conduit concretions |

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