**Table S2** Full list of KEGG Orthologs (KO) involved in carbon, nitrogen and sulfur conversions that were searched for in the Organic Lake metagenome.

|  |  |  |  |
| --- | --- | --- | --- |
| Process | Gene | KO | Notes |
| C fixation | ribulose-bisphosphate carboxylase large (*cbbL*) | K01601 | Calvin cycle |
| ribulose-bisphosphate carboxylase small (*cbbS*) | K01602 | Calvin cycle |
| phosphoribulokinase (*prkB*) | K00855 | Calvin cycle |
|  | ATP-citrate lyase alpha (*aclA*) | K15230 | rTCA cycle |
|  | ATP-citrate lyase beta (*aclB*) | K15231 | rTCA cycle |
| citryl-CoA lyase (*ccl*) | K15234 | rTCA cycle |
| citryl-CoA synthetase (*ccsB*) | K15233 | rTCA cycle |
| carbon monoxide dehydrogenase/acetyl-CoA synthase alpha (*cdhA*) | K14138 | WL |
| carbon monoxide dehydrogenase/acetyl-CoA synthase beta (*cdhB*) | K00190 | WL |
| Respiration | cytochrome C oxidase subunit I (*coxI*) | K02256 | Eucaryotic |
|  | cytochrome C oxidase subunit III (*coxIII*) | K02262 | Eucaryotic |
| cytochrome C oxidase subunit I (*coxA*) | K02274 | Bacterial |
| cytochrome C oxidase subunit III (*coxC*) | K02276 | Bacterial |
| Fermentation | L-lactate dehydrogenase (*ldh*) | K00016 |  |
| pyruvate:ferredoxin oxidoreductase alpha (*porA*) | K00169 |  |
| pyruvate:ferredoxin oxidoreductase beta (*porB*) | K00170 |  |
| CO oxidation | carbon-monoxide dehydrogenase large (*coxL*) | K03520 |  |
| carbon-monoxide dehydrogenase medium (*coxM*) | K03519 |  |
| carbon-monoxide dehydrogenase small (*coxS*) | K03518 |  |
| AAnP | photosynthetic reaction center L subunit (*pufL*) | K08928 |  |
| photosynthetic reaction center M subunit (*pufM*) | K08929 |  |
| Methanogenesis | coenzyme M methyl reductase (*mcrB*) | K00401 |  |
| methyl coenzyme M reductase system | K00400 |  |
| CH4 oxidation | soluble methane monooxygenase | K08684 |  |
| N fixation | nitrogenase (*anfG*) | K00531 |  |
| nitrogenase molybdenum-iron protein alpha (*nifD*) | K02586 |  |
| nitrogenase iron protein (*nifH*) | K02588 |  |
| nitrogenase molybdenum-iron protein beta (*nifK*) | K02591 |  |
| Denitrification | nitric oxide reductase (*norB*) | K02305 |  |
| nitric oxide reductase (*norC*) | K04561 |  |
| nitrous oxide reductase (*nosZ*) | K00376 |  |
| DNRA | periplasmic cytochrome c-552 (*nrfA*) | K03385 |  |
| N dissimilation | hydroxylamine oxidase (*hao*) | K10535 | *hzo*-like |
| N mineralization/ assimilation | glutamate dehydrogenase (*gudB*, *rocG*) | K00260 |  |
| glutamate dehydrogenase (NAD(P)+) | K00261 |  |
| glutamate dehydrogenase (*gdhA*) | K00262 |  |
| N assimilation | assimilatory nitrate reductase | K00360 |  |
| assimilatory nitrate reductase (*nasA*) | K00372 |  |
| assimilatory nitrate reductase (*narG*) | K00367 |  |
| glutamine synthetase (*glnA*) | K01915 |  |
| glutamate synthetase (NADPH/NADH)(*gltB*) | K00265 |  |
| glutamate synthetase (ferredoxin) (*gltS*) | K00284 |  |
| Nitrification | ammonia monooxygenase subunit A (*amoA*) | K10944 |  |
| ammonia monooxygenase subunit B (*amoB*) | K10945 |  |
| ammonia monooxygenase subunit C (*amoC*) | K10946 |  |
| DSR | adenylylsulfate reductase subunit A (*aprA*) | K00394 | SRB related |
| adenylylsulfate reductase subunit B (*aprB*) | K00395 | SRB related |
| sulfite reductase (*dsrA*) | K11180 | SRB related |
| sulfite reductase (*dsrB*) | K11181 | SRB related |
| ASR | adenylyl sulfate kinase (*cysC*) | K00860 |  |
| sulfate adenylyltransferase (*cysN*) | K00956 |  |
| sulfate adenylyltransferase (*cysD*) | K00957 |  |
| S mineralization | cysteine diogenase (*cdoI*) | K00456 |  |
| thiosulfate/3-Mercaptopyruvate sulfurtransferase ( *sseA*) | K01011 |  |
| DMSO reduction | anaerobic dimethyl sulfoxide reductase subunit A (*dmsA*) | K07306 |  |

Abbreviations: rTCA, tricarboxylic acid cycle; WL, Wood-Ljungdahl pathway; AAnP, aerobic anoxygenic phototrophy; DNRA, dissimilatory nitrate reduction to ammonia; anaerobic ammonia oxidation; ASR, assimilatory sulfate reduction; DSR, dissimilatory sulfate reduction; SRB, sulfate-reducing bacteria.