Supplementary materials for

Title: The Coupling of Carbon, Nitrogen and Sulphur Transformational Processes in River Sediments Based on Correlationship among the Functional Genes

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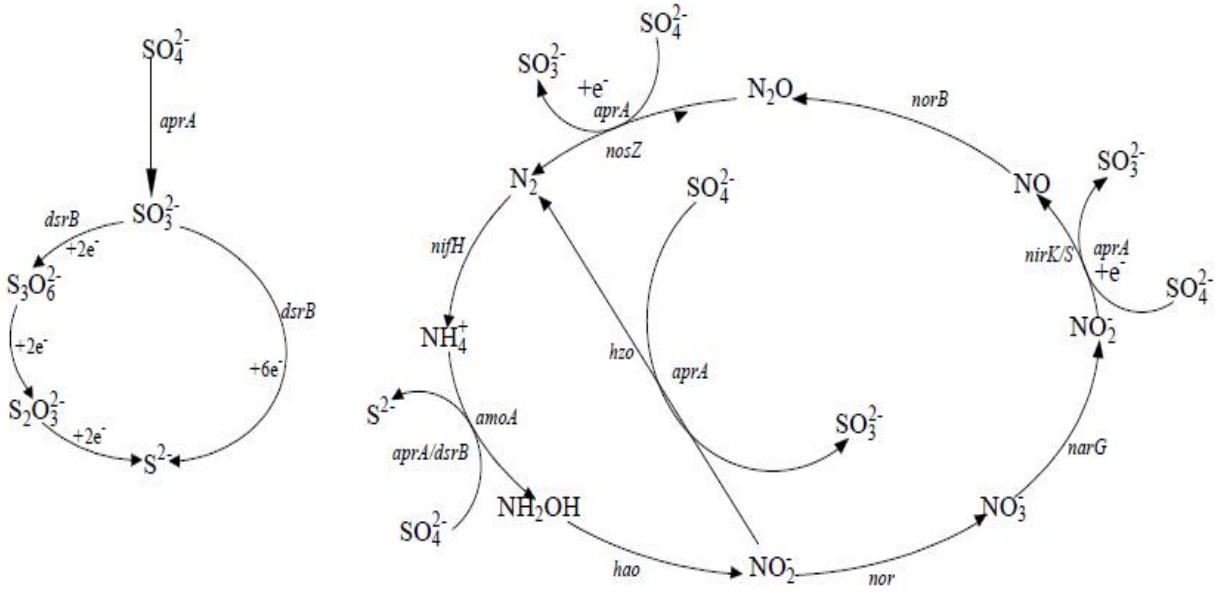
Table S1 Primer pairs for *q*PCR assays performed

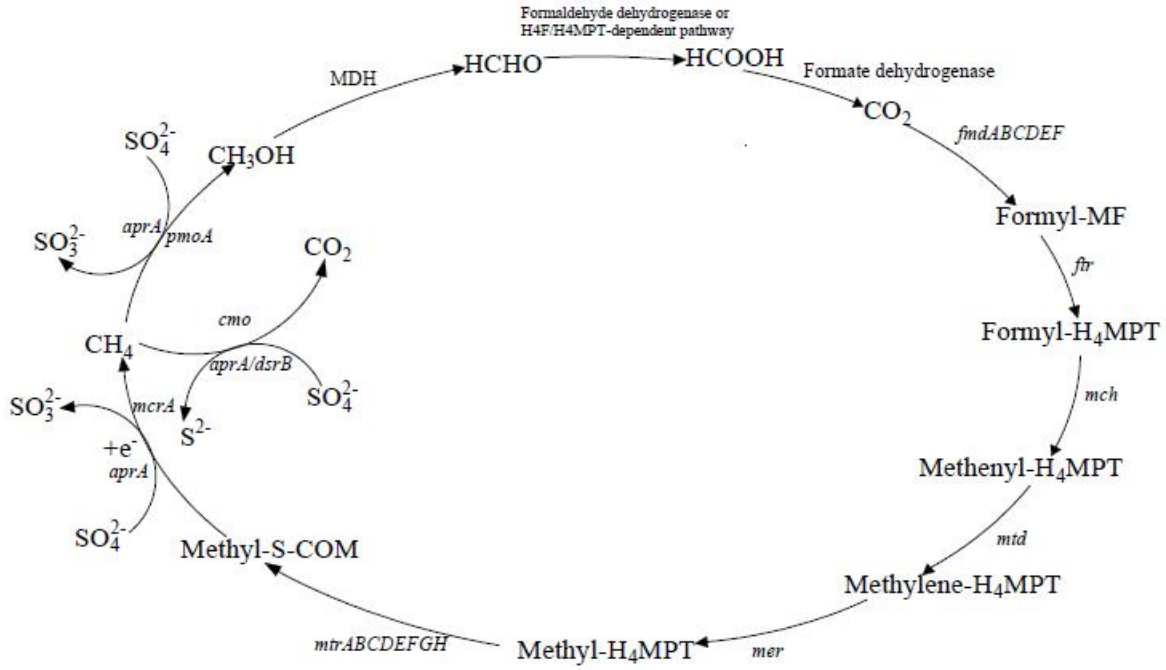
Target gene	Primers (References)	Prime sequence (5'-3')
amoA of AOA	amoA-1F/ amoA-2R (Rotthauwe et al., 1998)	GGGGTTTCTACTGGTGGT CCCCTCKGSAAAGCCTTCTTC
amoA of AOB	Arch-amoAF/Arch-amoAR (Francis et al., 2005)	STAATGGTCTGGCTTAGACG GCGGCCATCCATCTGTATGT
hzo	hzocl1F1/hzocl1R2 (Schmid et al., 2010)	TGYAAGACYTGYCAYTGG ACTCCAGATRTGCTGACC
nirS	Cd3aF/R3cd (Throbäck et al., 2004)	GTSAACGTSAAGGAACSGG GASTTCGGRTGSGTCTTGA
*nir*K	nirK876/nirK1040 (Henry et al., 2004)	ATCATGGTSCTGCCGCG GCCTCGATCAGRTTGTGGTT
*nos*Z2	nosZ2F/nosZ2R (Henry et al., 2006)	CGCRACGGCAASAAGGTSMSSGT CAKRTGCAKSGCRTGGCAGAA
cmo	cmo182/cmo568 (Luesken et al., 2011a;Luesken et al., 2011b)	TCACGTTGACGCCGATCC GATGGGGATGGAGTATGTGC
mcrA	MCRf/MCRr (Lueders and Friedrich, 2003)	TAYGAYCARATHTGGYT ACRTTCATNGCRTARTT
pmoA	A189F/Mb601R (Holmes et al., 1995;Kolb et al., 2003)	GGNGACTGGGACTTCTGG ACRTAGTGGTAACCTTGYAA
*pmoA*1	II223F/II646R (Kolb et al., 2003)	CGTCGTATGTGGCCGAC CGTGCCGCGCTCGACCATGYG
*pmoA*2	pmoA206f/pmoA703b (Yimga et al., 2003)	GGNGACTGGGACTTCTGGAT CGACTTCAAGGATCG GAASGCNGAGAAGAASGCG
dsrB	DSRp2060F/DSR4R (Foti et al., 2007)	GCGACCGGAACGACGT CAACATCGTYCAYACCCAGGG GTGTAGCAGTTACCGCA
aprA	AprA-1-FW/AprA-5-rv (Meyer and Kuever, 2007)	TGGCAGATCATGATYMATGG GCGCCAACYGGRCCTTA

Table S2 Potential reactions in the coupling transformation of C, N and S

Coupled systems	Potential reactions	Functional genes invovled
Aerobic ammonia	NH_2OH+CH_3-S-COM→CH_4+NHOH-S-COM	*AOA*

	oxidation coupled to methanogenesis	NH_4^++CH_3-S-COM→CH_4+NH_3-S-COM CH_4+NH_2OH+O_2→CH_3OH+NO_2^-+H_2O CH_4+NH_4^++O_2→CH_3OH+NO_2^-+H_2O	*AOB* *mcrA*
	Methanogenesis-anammox-denitrification	CH_3-S-COM+HS-COB→CH_4+COB-S-S-COM NO_2^-+$2H^+$+e^-→NO+H_2O NO+NH_4^+-e^-→N_2+H^++H_2O NO_2^-+NH_4^+→N_2+$2H_2O$	*mcrA* *nirK* *nirS* *hzo*
C-N	Aerobic methane oxidation coupled to denitrification (AME-D)	CH_4+O_2+NO_2^-+H^+→N_2O+CO_2+H_2O or CH_4+O_2+NO_2^-+H^+→N_2+CO_2+H_2O 1)CH_4+O_2+$2H^+$→CH_3OH+H_2O+$2e^-$ 2)CH_3OH+O_2→CO_2+H_2O 3)CH_3OH+NO_2^-+H^+→N_2O+H_2O+CO_2 or CH_3OH+NO_2^-+H^+→N_2+H_2O+CO_2	*pmoA* *pmoA*1 *pmoA*2 *nirK*/*S* *nosZ*
	Nitrite-dependent anaerobic methane oxidation	$3CH_4$+$8NO_2^-$+$8H^+$→$3CO_2$+$4N_2$+$10H_2O$	*cmo*
	Simultaneous denitrification and methanogenesis (SDM)	CH_3OH+NO_2^-→N_2+CO_2+OH^-+H_2O CH_3OH→H_2O+CO_2+CH_4	*nirK*/*S* *nosZ*
	Aerobic methane oxidation coupled to ammoxidation	CH_4+NH_4^++O_2→CH_3OH+NO_2^-+H_2O	*pmoA, pmoA*1, *pmoA*2 AOA, AOB
C-S	Sulphate-dependent anaerobic methane oxidation	*aprA* CH_4+ SO_4^{2-}→HCO_3^-+HS^-+H_2O	
	Ammoxidation coupled to sulfate reduction	NH_2OH+SO_3^{2-}→NO_2^-+S^{2-}+H_2O NH_2OH+SO_3^{2-}→NO_2^-+$S_3O_6^{2-}$+H_2O NH_4^++SO_3^{2-}→NO_2^-+S^{2-}+H_2O NH_4^++SO_3^{2-}→NO_2^-+$S_3O_6^{2-}$+H_2O	AOA, AOB *dsrB*
N-S	Anammox coupled to sulfate reduction	$2NH_4^+$+SO_3^{2-}→N_2+S^{2-}+$4H_2O$ 1)$3SO_3^{2-}$+$4NH_4^+$→$3S^{2-}$+$4NO_2^-$+$4H_2O$+$8H^+$ $2NO_2^-$+$2NH_4^+$→$2N_2$+$4H_2O$ SO_3^{2-}+$4NH_4^+$→$S_3O_6^{2-}$+$4NO_2^-$+$4H_2O$+$8H^+$ 2)$3SO_3^{2-}$+$4NH_4^+$→$S_3O_6^{2-}$+$4NO_2^-$+$4H_2O$+$8H^+$ $2NO_2^-$+$2NH_4^+$→$2N_2$+$4H_2O$	*hzo* *dsrB* *aprA*


SO_4^{2-}
aprA
SO_3^{2-}
dsrB
+2e⁻
$S_3O_6^{2-}$
dsrB
+2e⁻
+6e⁻
$S_2O_3^{2-}$
+2e⁻
S^{2-}
SO_4^{2-}
SO_3^{2-}
+e⁻
aprA
N_2O
norB
nosZ
N_2
SO_4^{2-}
NO
SO_3^{2-}
nifH
nirK/S
aprA
+e⁻
SO_4^{2-}
NH_4^+
hzo
aprA
NO_2^-
S^{2-}
amoA
SO_3^{2-}
aprA/dsrB
SO_4^{2-}
narG
NH_2OH
NO_3^-
hao
NO_2^-
nor


Formaldehyde dehydrogenase or
H4F/H4MPT-dependent pathway
MDH
HCHO
HCOOH
Formate dehydrogenase
CO_2
fmdABCDEF
SO_4^{2-}
CH_3OH
Formyl-MF
aprA
pmoA
SO_3^{2-}
ftr
CO_2
cmo
Formyl-H_4MPT
CH_4
aprA/dsrB
SO_4^{2-}
mch
SO_3^{2-}
mcrA
S^{2-}
Methenyl-H_4MPT
+e⁻
aprA
mtd
SO_4^{2-}
Methylene-H_4MPT
Methyl-S-COM
mtrABCDEFGH
Methyl-H_4MPT
mer

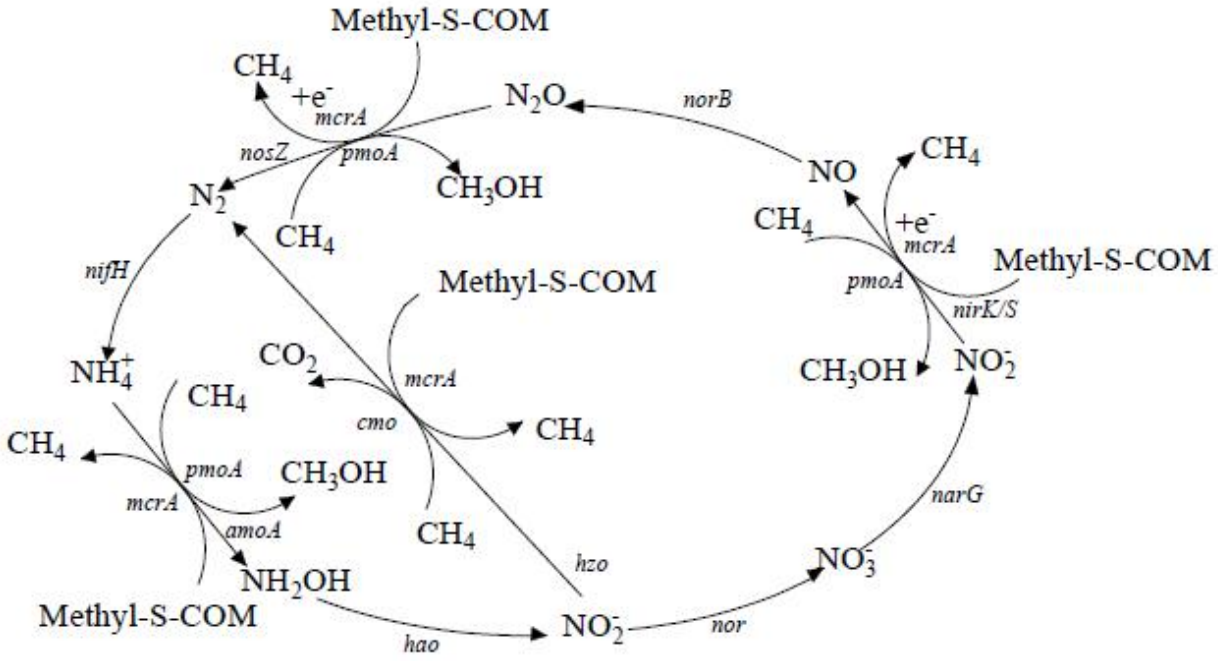


Figure S1 The pathway of C-, N- and S-cycles and the coupling systems of C-N-S