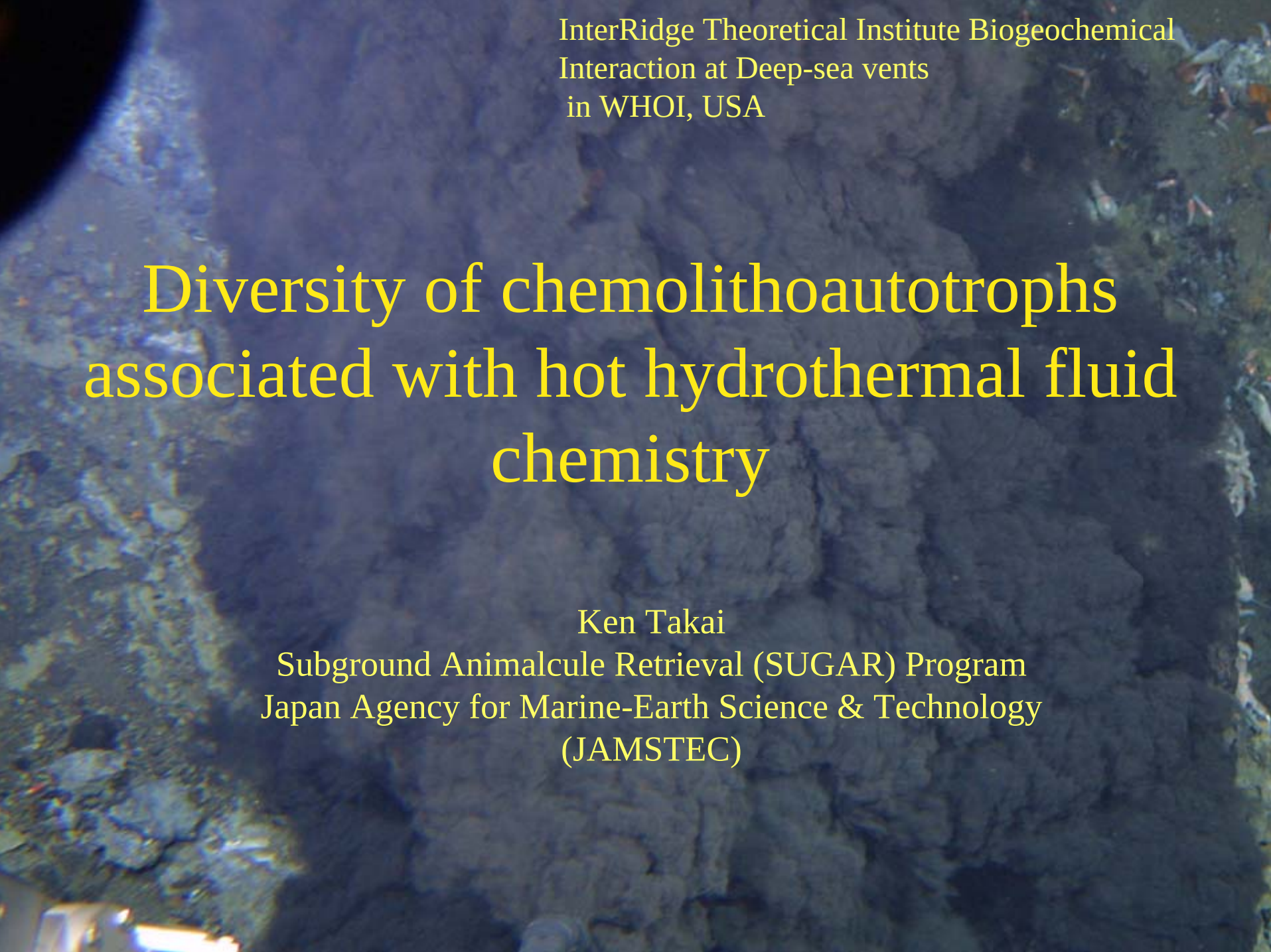

InterRidge Theoretical Institute Biogeochemical Interaction at Deep-sea vents
in WHOI, USA

Diversity of chemolithoautotrophs associated with hot hydrothermal fluid chemistry

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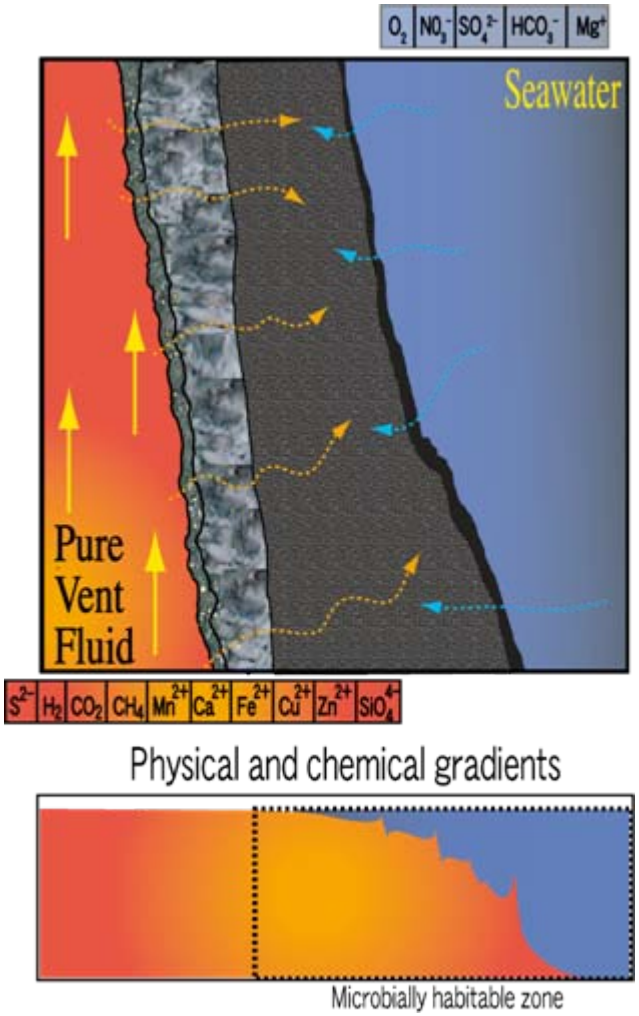
Subground Animalcule Retrieval (SUGAR) Program
Japan Agency for Marine-Earth Science & Technology
(JAMSTEC)

Key Question:

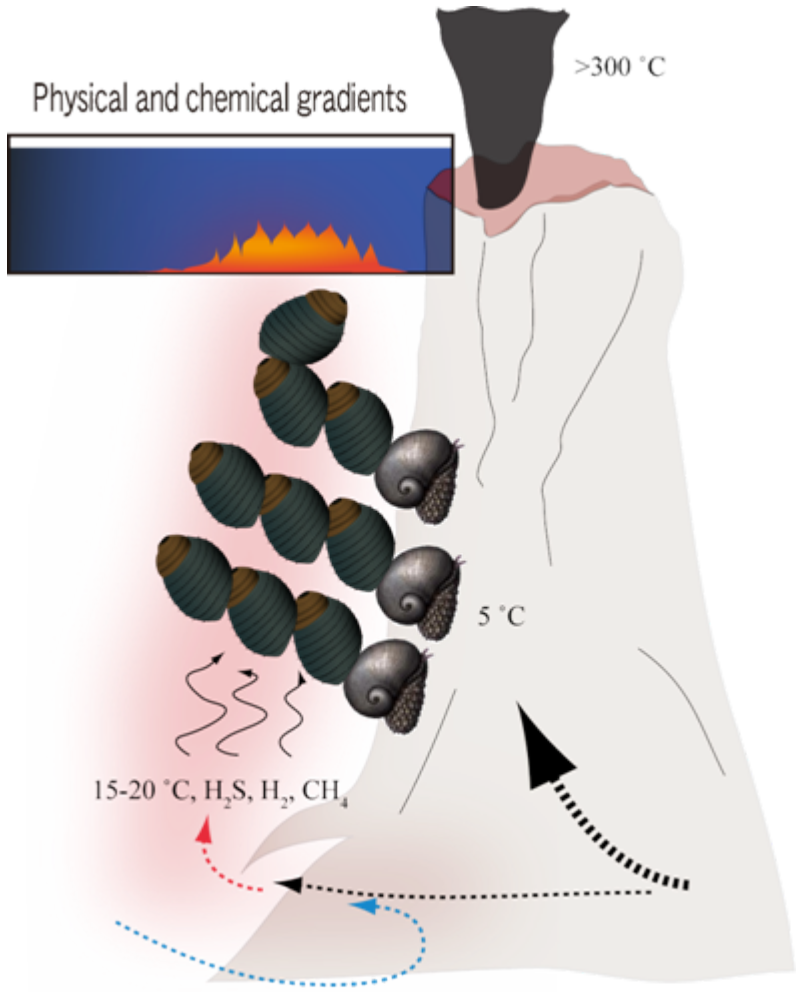
Is diversity of chemolithoautotrophs facies to physical and chemical conditions of their habitats?

All the microbial habitats in deep-sea hydrothermal systems are created by mixing of hydrothermal fluids and ambient waters

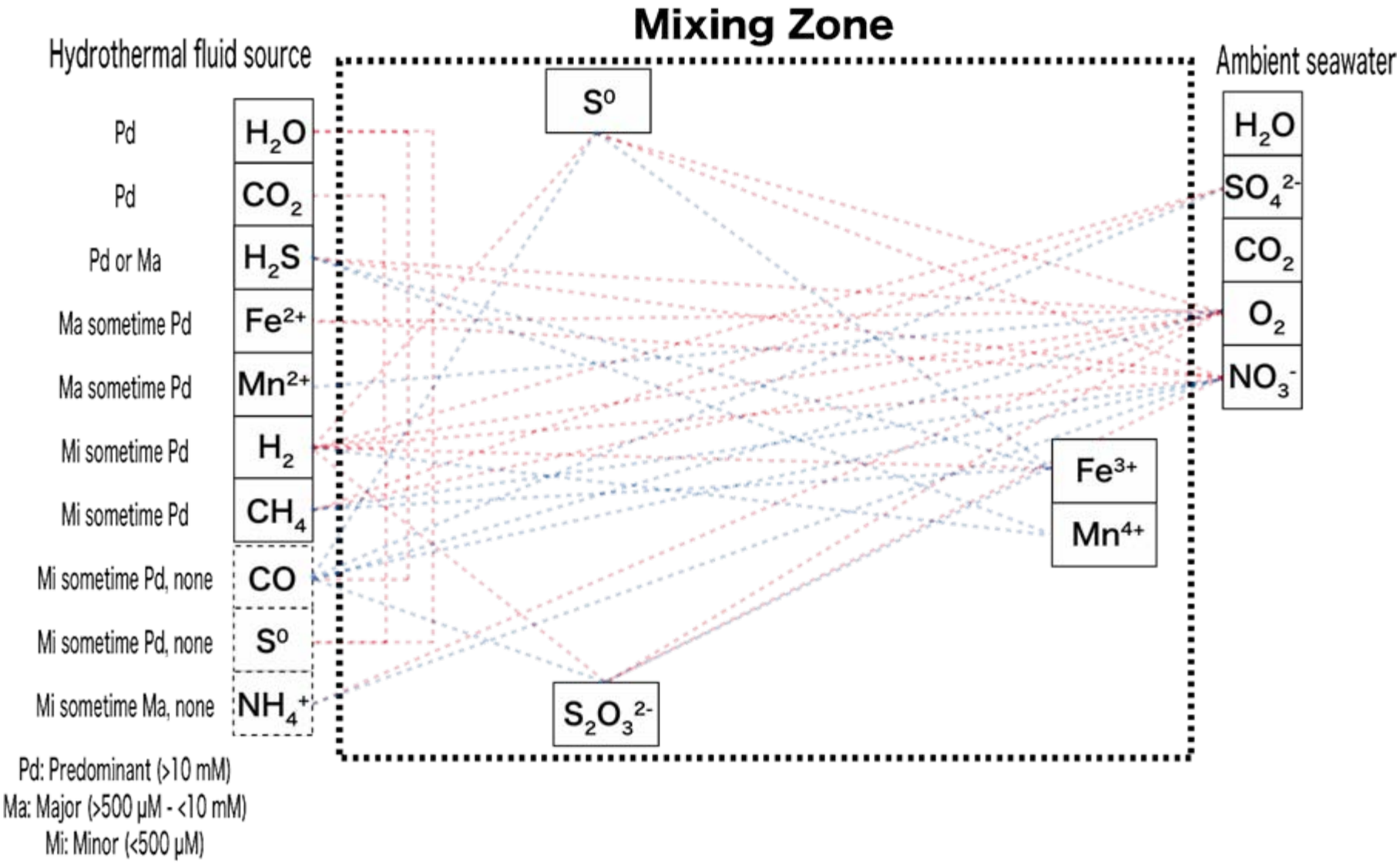
in Chimneys



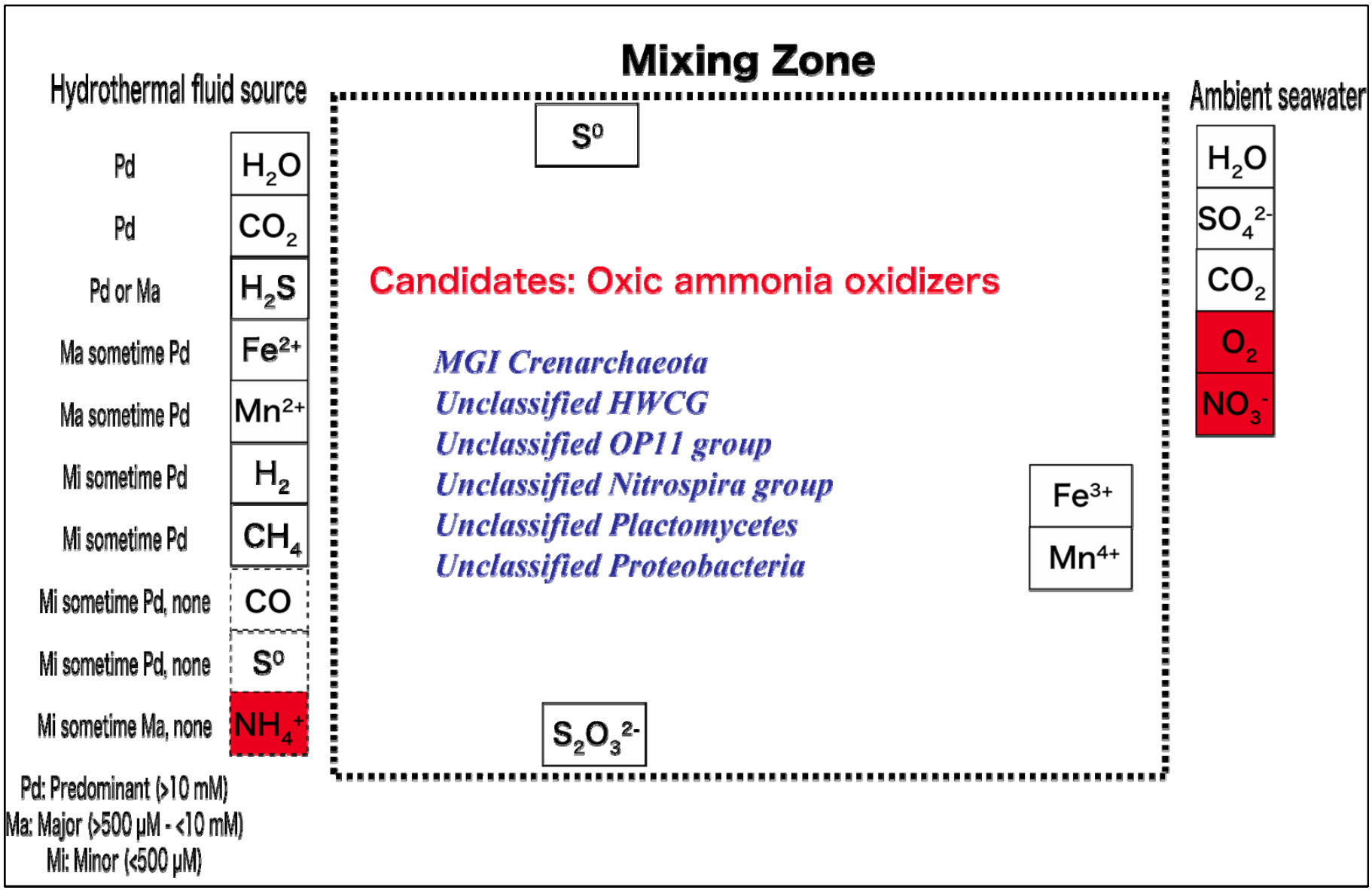
in Macrofunal colonies



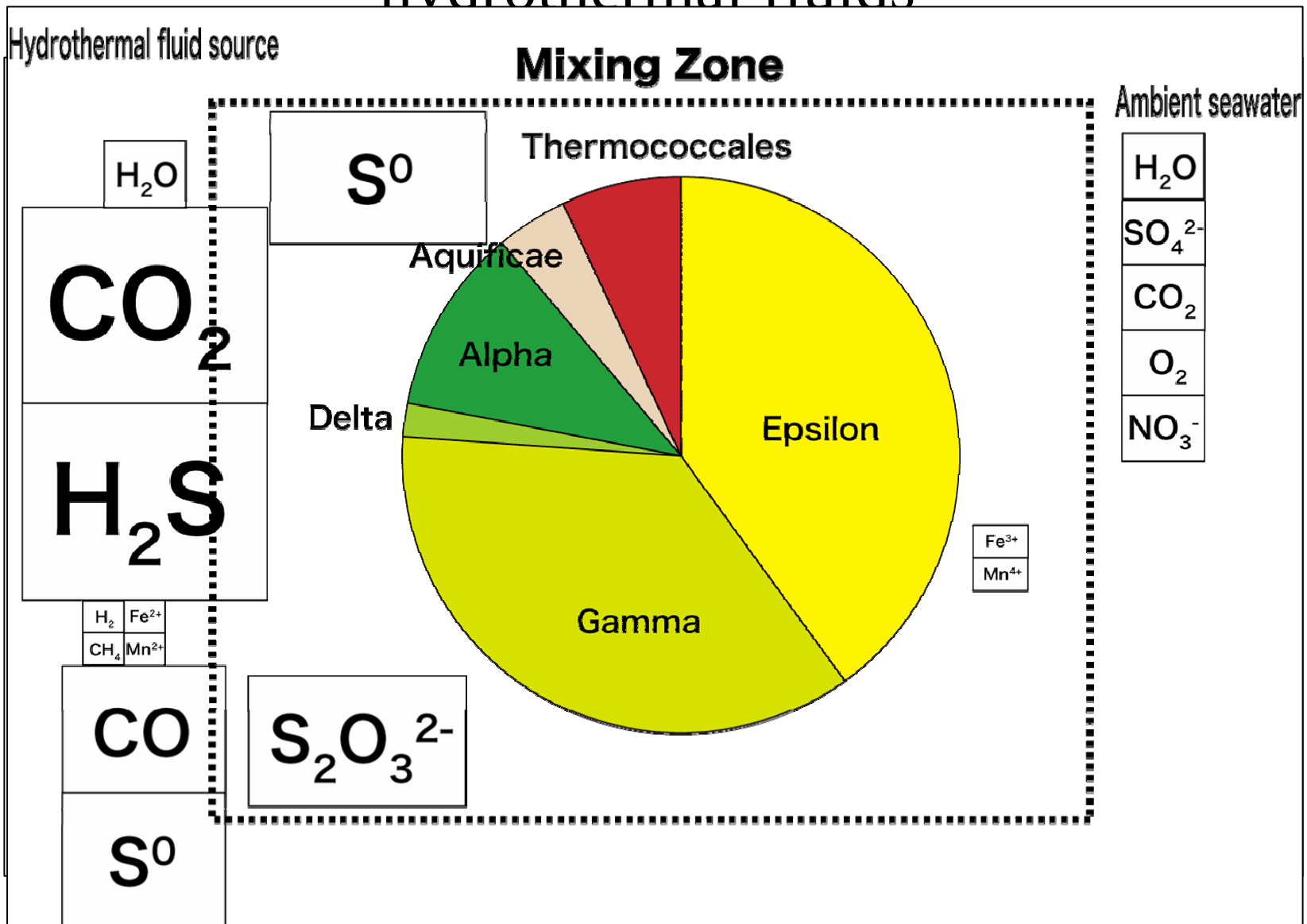
Mixing prepares chemolithotrophically available redox couples



What kinds of chemolithotrophs are identified?



Chemolithoautotrophs are strongly dependent on inputs of electron donors/acceptors from hydrothermal fluids



Do chemolithoautotrophs actually respond to hydrothermal fluid chemistry?

Physical and chemical characteristics of hydrothermal fluids are different

between the fields: Inter-fields variation

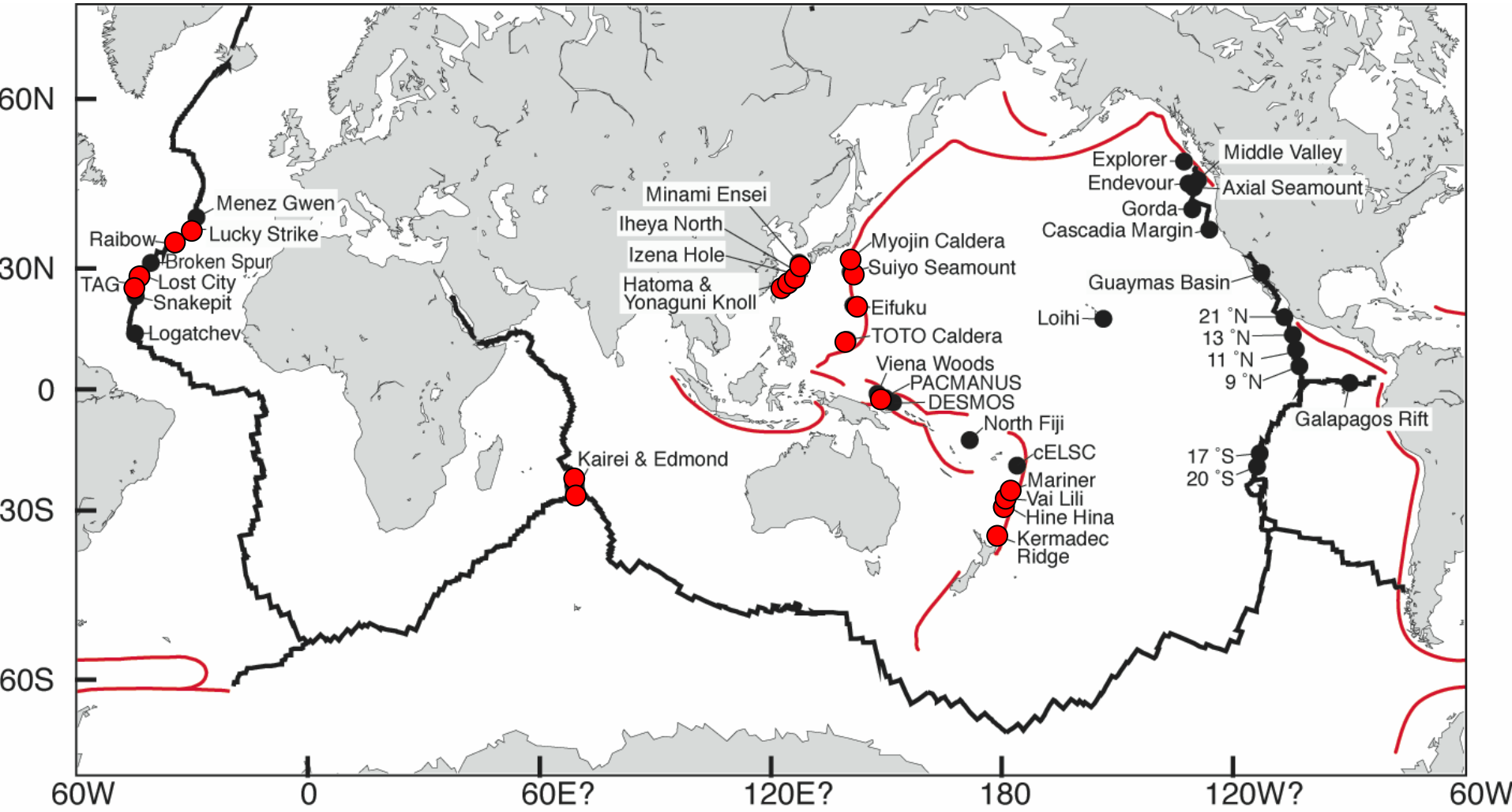
in a field: Intra-field variation

Thus, compositions of chemolithoautotrophs associated with hydrothermal fluids are different

between the fields: Inter-fields variation

in a field: Intra-field variation

Examples & Evidences



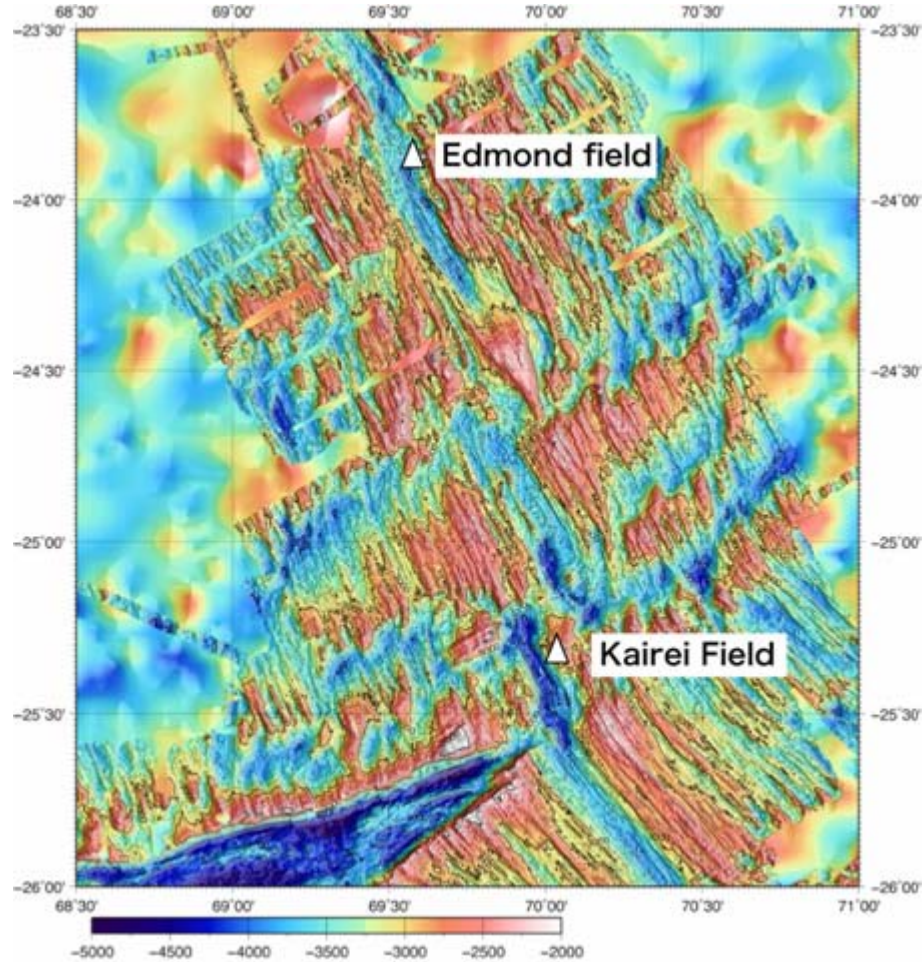
Examples & Evidences

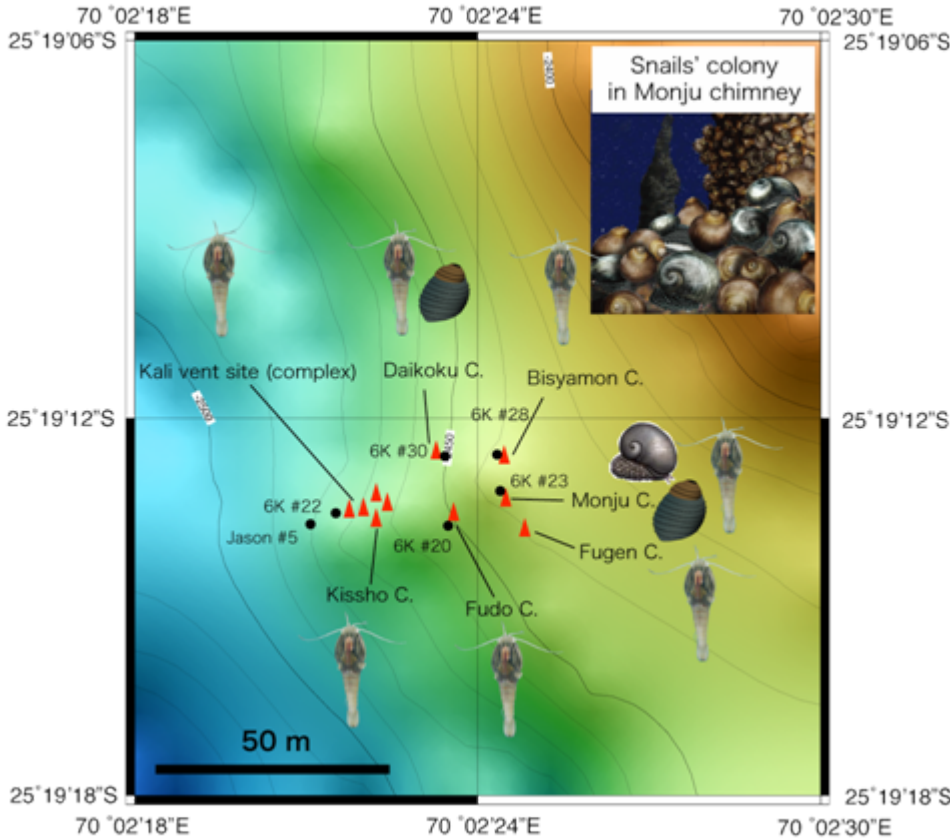
Kairei Field in Central Indian Ridge

now found to be an ultramafics-associated hydrothermal system

H_2-enriched, ^{13}C-depleted CH_4 bearing hydrothermal fluids

Hashimoto et al., 2001; Van Dover et al., 2001; 2003; Gamo et al., 2001; Takai et al., 2004; 2006; Gallant et al., 2005
Waren et al., 2003; Goffredi et al., 2005; Suzuki et al., 2005; 2006



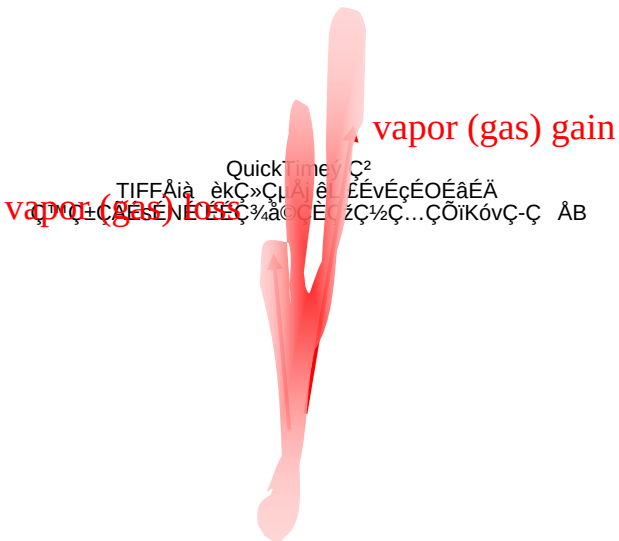


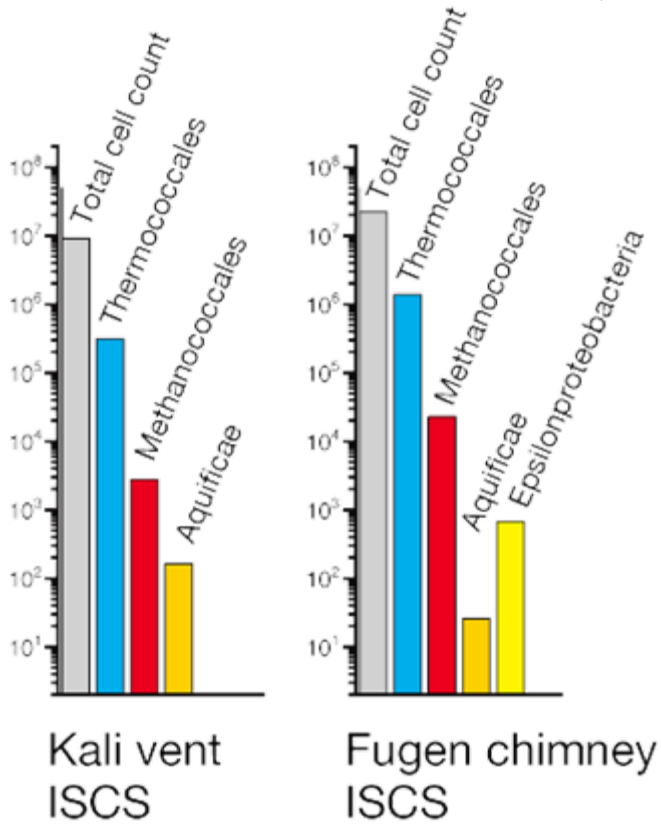
Examples & Evidences

Gallant et al., 2005; Takai et al., 2004

8.2 mM	7.9 mM	H_2
0.08 mM	0.19 mM	CH_4
-13.8‰	-18.5‰	$\delta^{13}C(CH_4)$

Kali vent Fugen chimney





Vapor-gained fluids harbor more abundant H_2-eating populations (particularly, hydrogenotrophic methanogens)

Gallant et al., 2005

Existence of HyperSLiME

Examples & Evidences

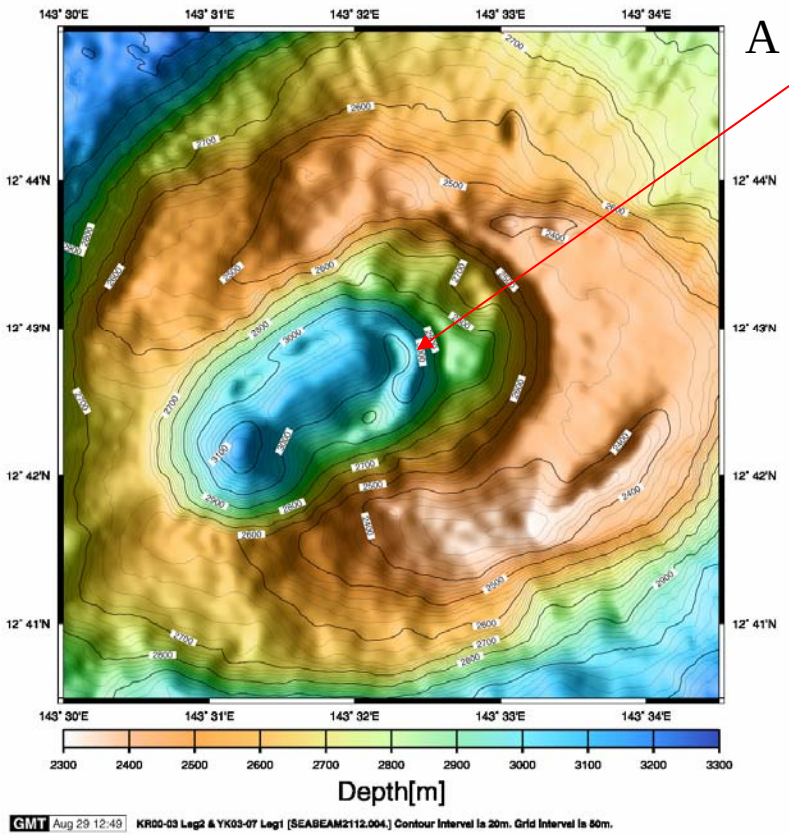
TOTO caldera in Mariana Volcanic Arc

a magmatic vapor-driven hydrothermal system

SO_2-, S^0- H_2S- & SO_4 enriched acidic hydrothermal fluids

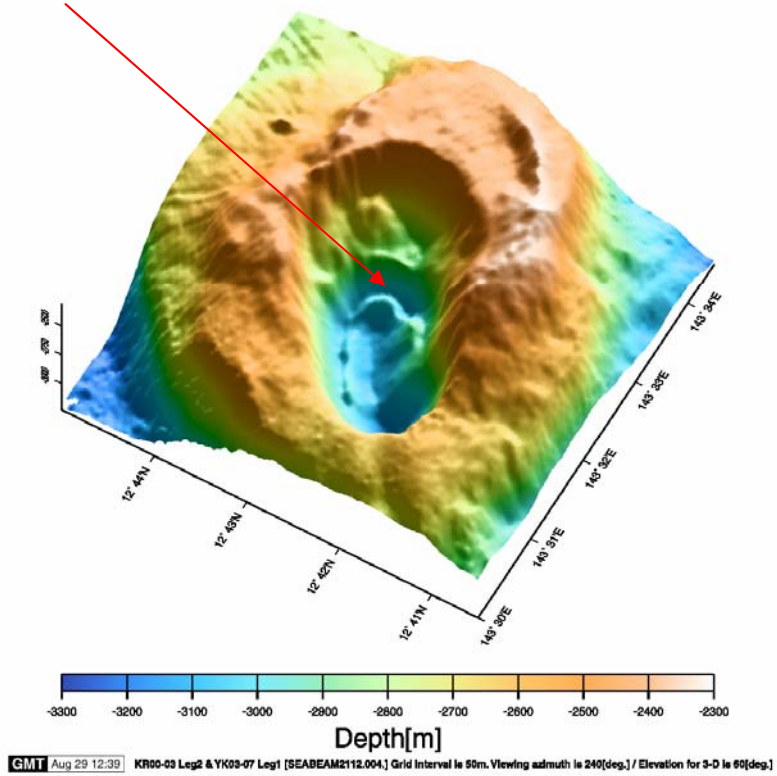
Gamo et al., 2004; Nakagawa et al., 2006

Batymetry map [TOTO caldera]

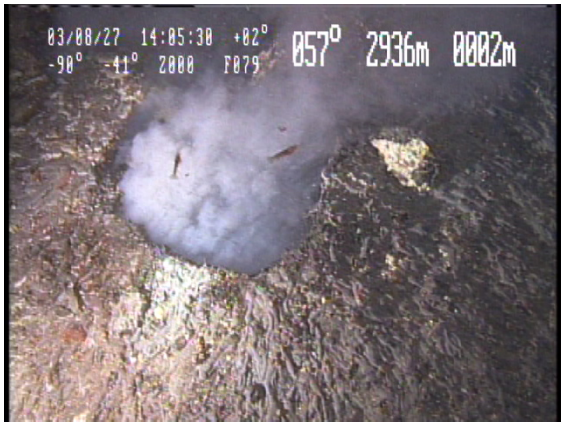


Whlel's eye view. [TOTO caldera]

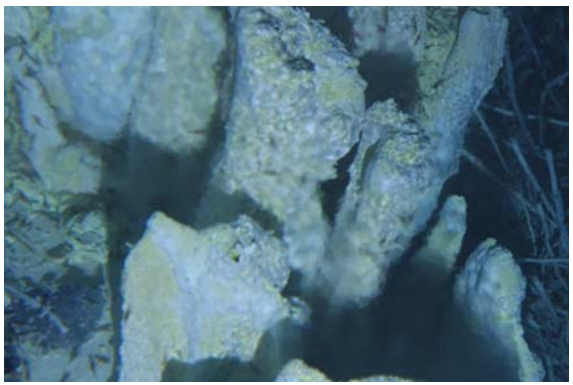
A lava dome & vents



Examples & Evidences

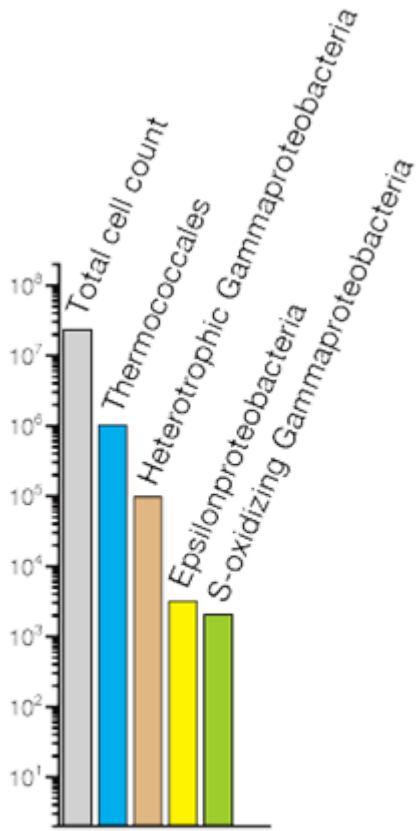


Higher T volcanic gas (white smoker):
$2SO_2$ ----> S^0 + SO_4
pH = 1.6



Lower T volcanic gas (clear smoker):
$2SO_2$ ----> S^{2-} + SO_4
pH = 5.2

14.6 mM	H_2S
25.3 mM	SO_4
-1.5‰	$\delta^{13}C(CO_2)$



Magmatic input creates unique, acidic, reduced sulfur compounds-enriched, microbial habitats

Proportion of sulfur-oxidizing (Epsilonproteobacteria & Gammaproteobacteria) & sulfur-reducing (Thermococcales & Acidiprofundus group) populations is increased

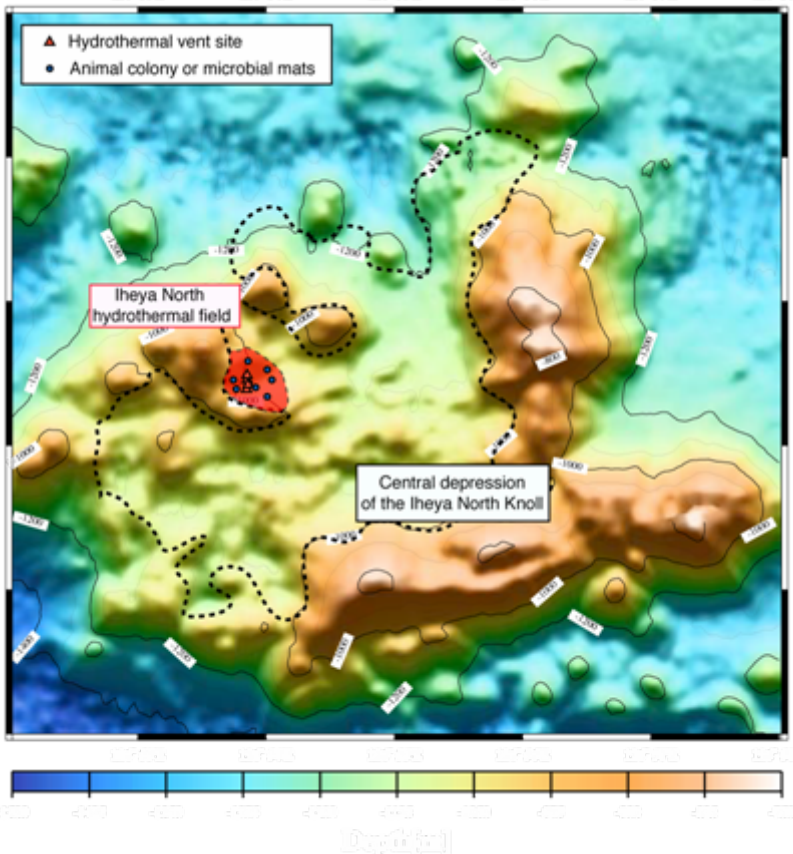
Examples & Evidences

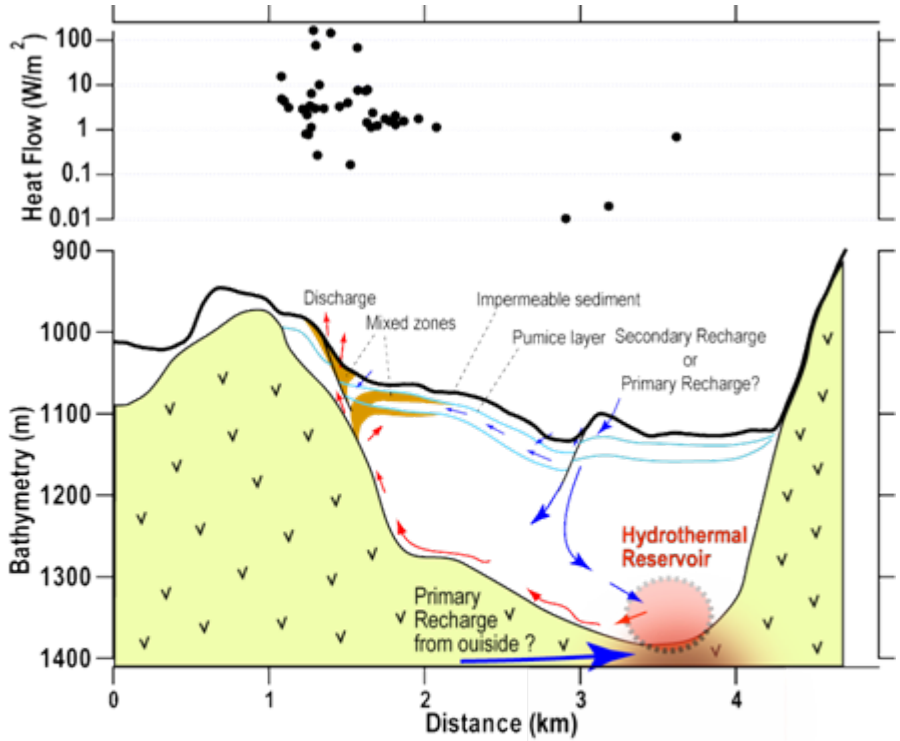
Iheya North field in Okinawa Trough

sediments-hosted, gaseous carbon-enriched hydrothermal system

phase-separation-controlled hydrothermal fluid chemistry

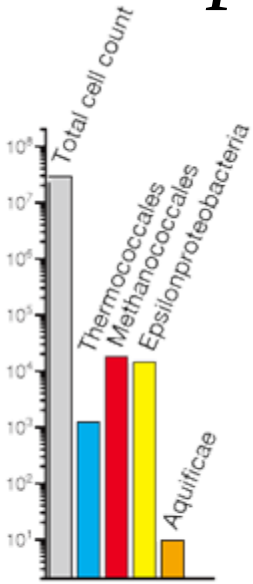
Nakagawa et al., 2005a; 2005b





Examples & Evidences

Nakagawa et al., 2005; Chiba et al., Tsunogai et al., Unpublished

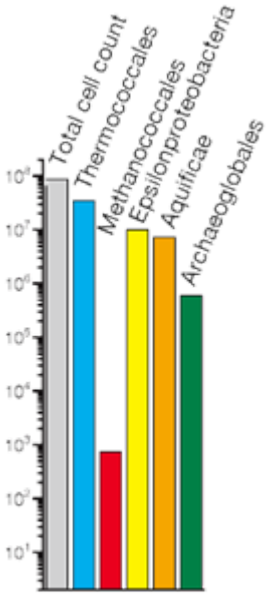


E18 vent

CO_2 436 mM
CH_4 216 mM
$\delta^{13}C(CO_2)$ -8.1‰
$\delta^{13}C(CH_4)$ -53.8‰

Cl 221 mM

Population of methanogens is increased



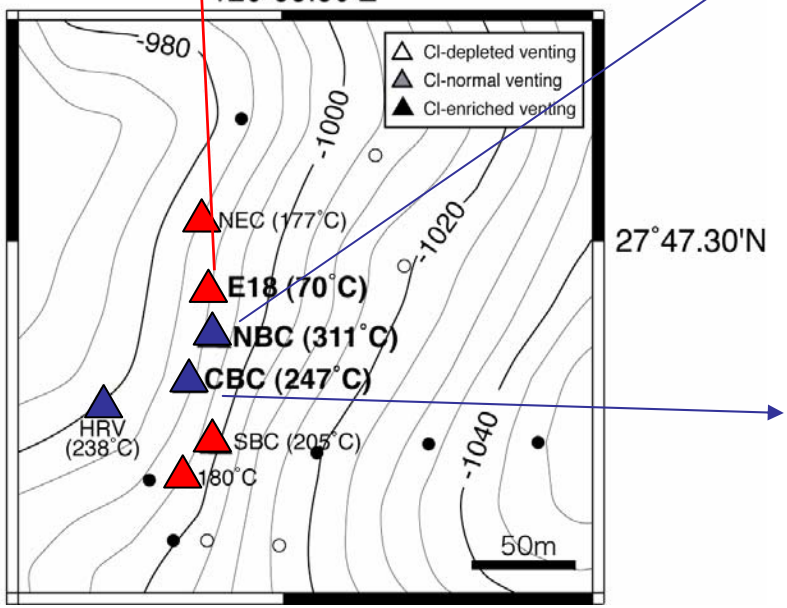
NBC chimney

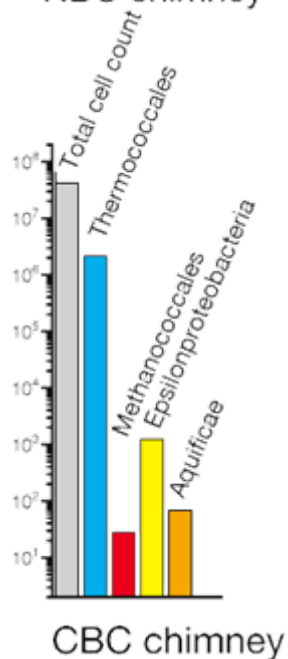
CO_2 74 mM
CH_4 71 mM
$\delta^{13}C(CO_2)$ -10.2‰
$\delta^{13}C(CH_4)$ -55.4‰

Cl 538 mM

Population of diverse chemolithoautotrophs is increased

ISCS





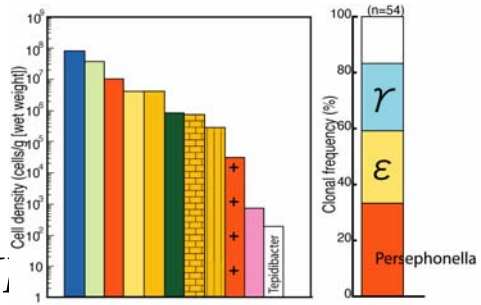
CBC chimney

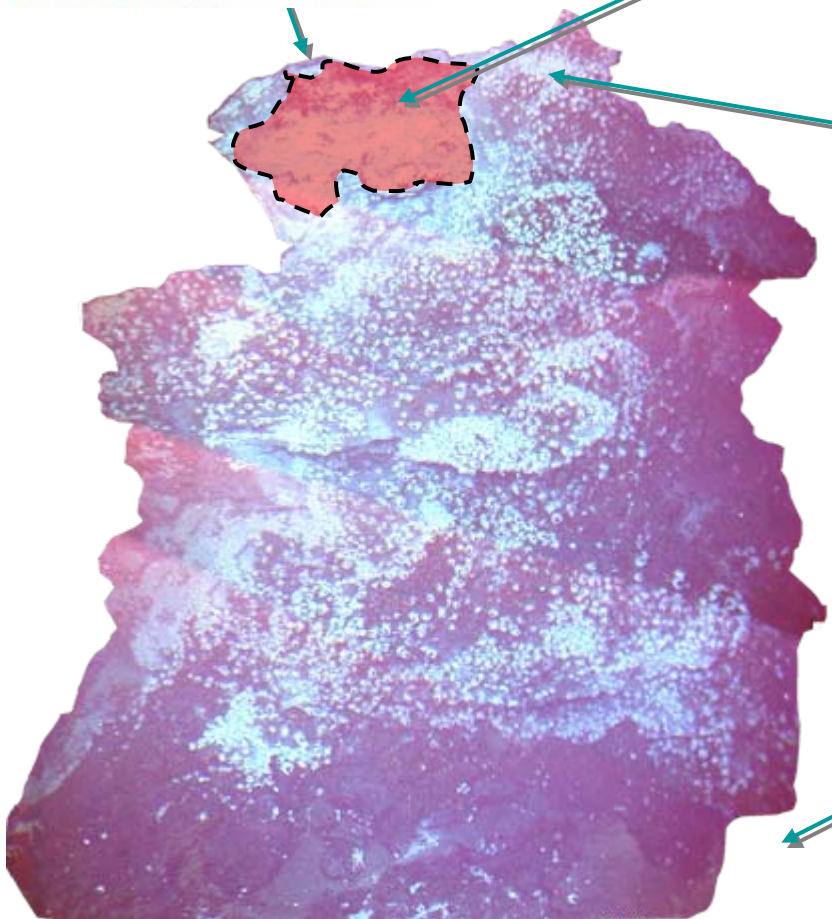
CO_2 173 mM
CH_4 96 mM
$\delta^{13}C(CO_2)$ -9.2‰
$\delta^{13}C(CH_4)$ -55.1‰

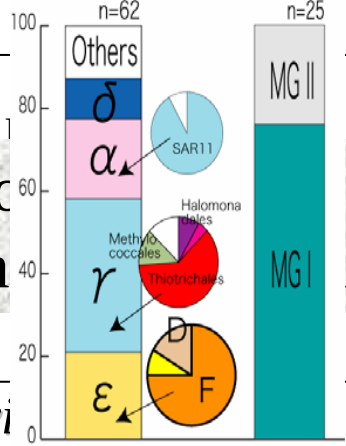
Cl 864 mM

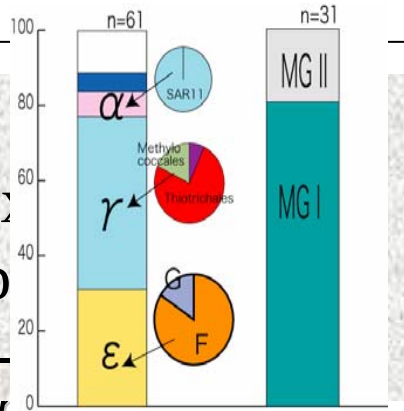
Examples & Evidences

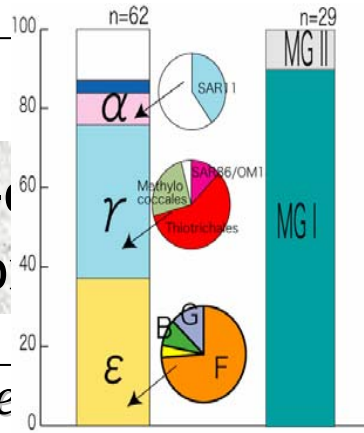
Different animals reside in different physical & chemical niches



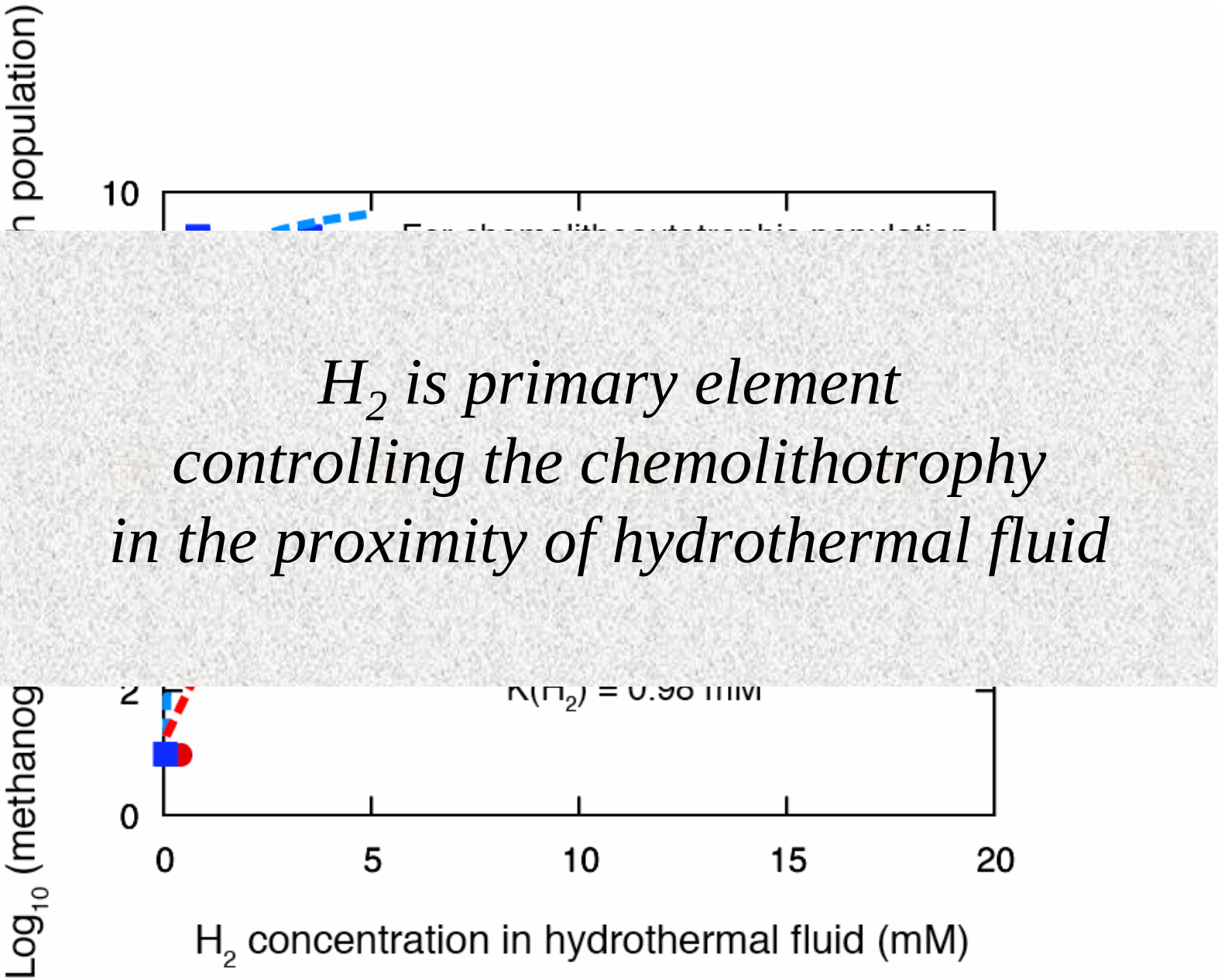








Examples & Evidences

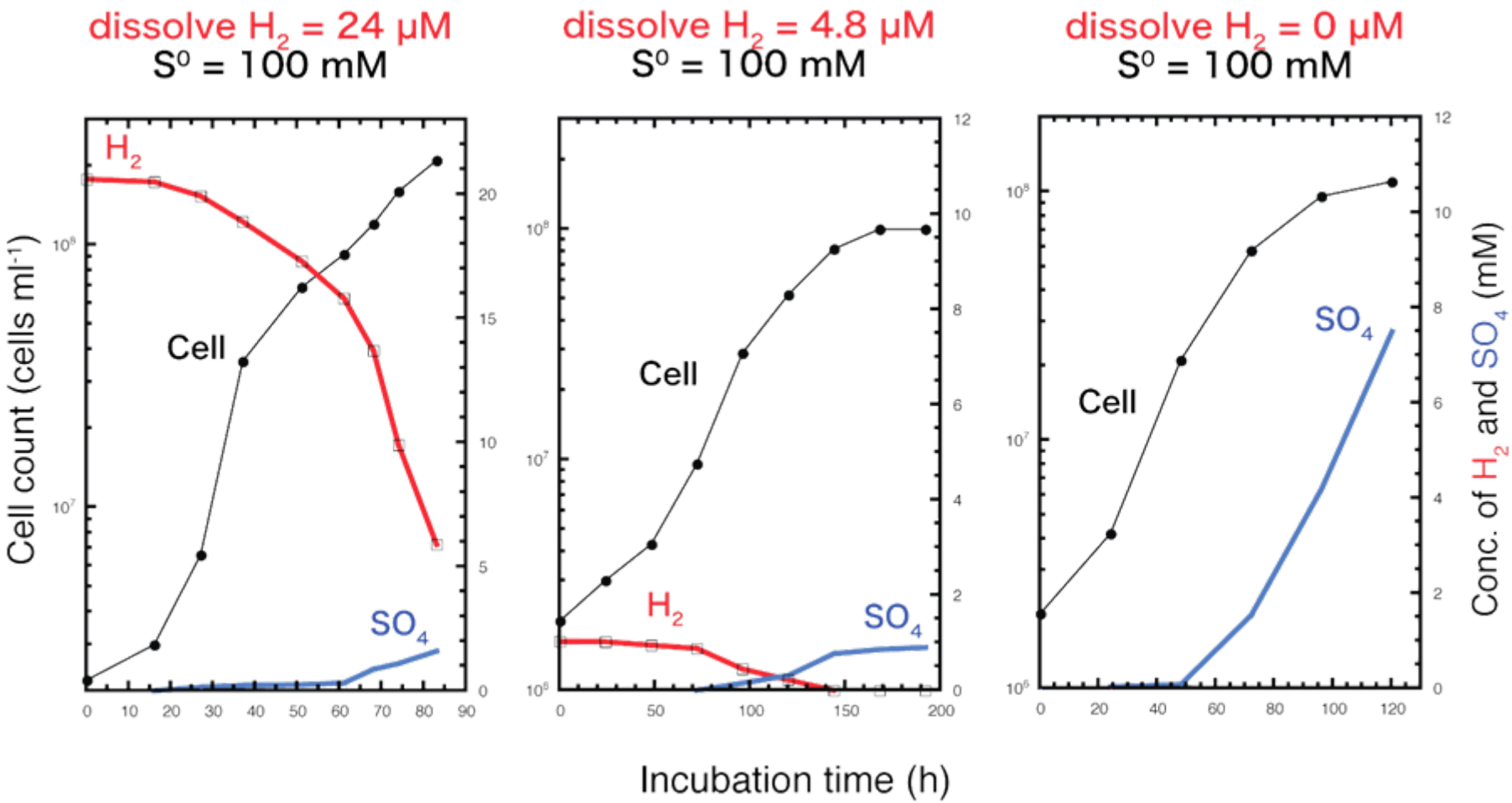


H_2 is primary element controlling the chemolithotrophy in the proximity of hydrothermal fluid

Co tions

How does it work?

- *Hydrogenetrophy is widely distributed*
- *Hydrogen is more affinitive*

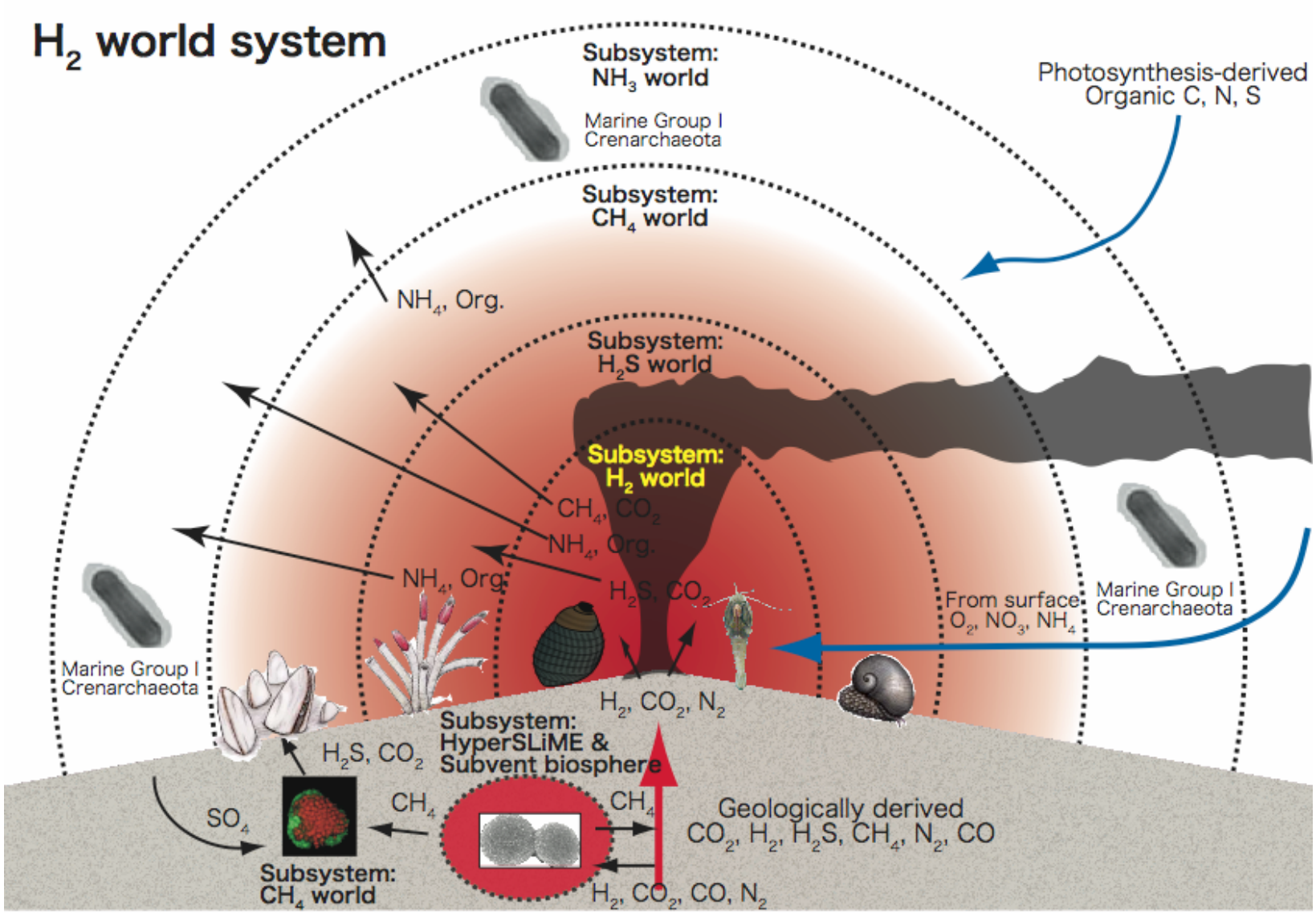


Hydrogenase menu

	Group	1	2b	3	4
	Cellular function	H2-uptake	H2-sensing	F420-reducing etc	H2-evolving
ε	*Nitratiruptor* sp. SB155-2	+	+	-	+
ε	*Sulfurovum* sp. NBC37-1	+ (X2)	+	-	+
ε	*Campylobacter jejuni*	+	-	-	-
ε	*Helicobacter pylori*	+	-	-	-
ε	*Wolinella succinogenes*	+	-	-	-
	Aquifex aeolicus	+ (X2)	+	-	-
	Methanocaldococcus jannaschii	-	-	+ (X2)	+ (X2)
	Ralstonia eutropha (plasmid)	+	+	+	-
	Escherichia coli	+ (X2)	-	-	+
	Geobacter sulfurreducens	+ (X2)	-	+ (X2)	-

Hypothesis:

Chemolithotrophic stratification model in deep sea hydrothermal vent



Key question:
Is diversity of chemolithoautotrophs facies to physical and chemical conditions of their habitats?

Yes. It will be more clearly proved in near future

Acknowledgement

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