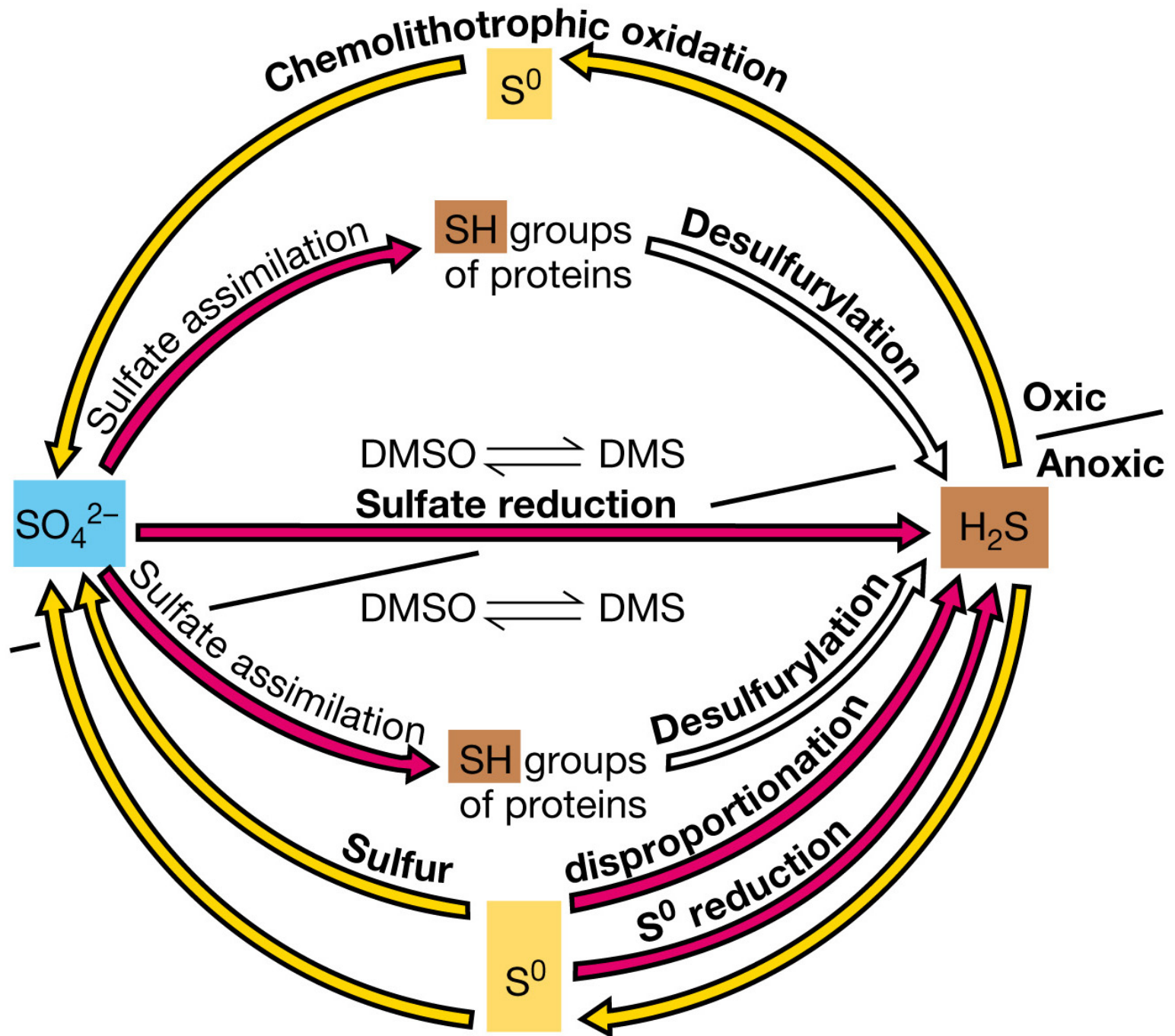


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# Key Processes and Prokaryotes in the Nitrogen Cycle

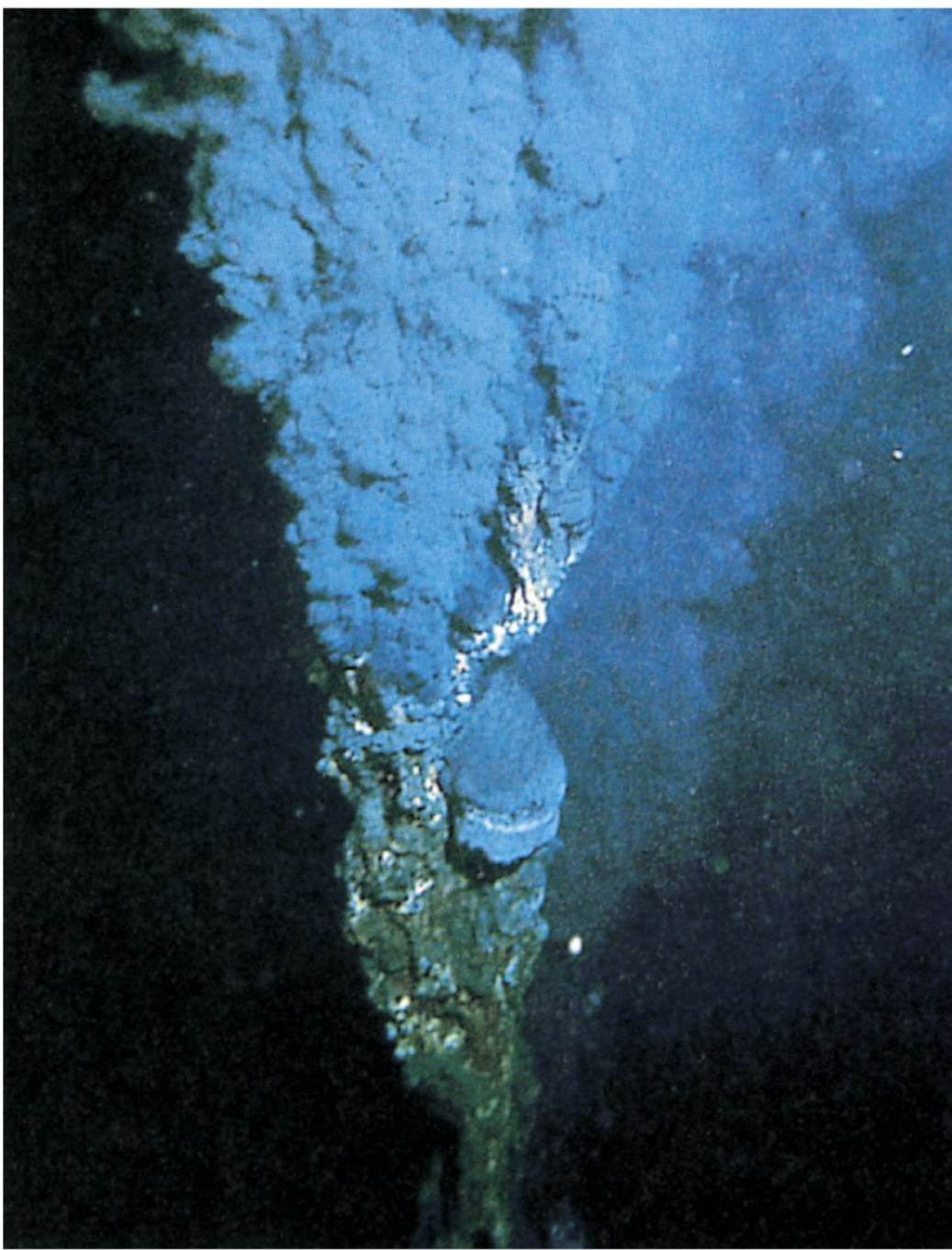
Processes	Example organisms
<b>Nitrification</b> ( $\text{NH}_4^+ \rightarrow \text{NO}_3^-$ ) $\text{NH}_4^+ \rightarrow \text{NO}_2^-$ $\text{NO}_2^- \rightarrow \text{NO}_3^-$	<i>Nitrosomonas</i> <i>Nitrobacter</i>
<b>Denitrification</b> ( $\text{NO}_3^- \rightarrow \text{N}_2$ )	<i>Bacillus</i> , <i>Paracoccus</i> , <i>Pseudomonas</i>
<b>N<sub>2</sub> Fixation</b> ( $\text{N}_2 + 8\text{H} \rightarrow \text{NH}_3 + \text{H}_2$ )	
Free-living Aerobic	<i>Azotobacter</i> Cyanobacteria
Anaerobic	<i>Clostridium</i> , purple and green bacteria
Symbiotic	<i>Rhizobium</i> <i>Bradyrhizobium</i> <i>Frankia</i>
<b>Ammonification</b> (organic-N $\rightarrow \text{NH}_4^+$ )	Many organisms can do this
<b>Anammox</b> ( $\text{NO}_2^- + \text{NH}_3 \rightarrow 2\text{N}_2$ )	<i>Brocadia</i>

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## Key Processes and Prokaryotes in the Sulfur Cycle

Process	Organisms
<b>Sulfide/sulfur oxidation</b> ( $\text{H}_2\text{S} \rightarrow \text{S}^0 \rightarrow \text{SO}_4^{2-}$ ) Aerobic	Sulfur chemolithotrophs ( <i>Thiobacillus</i> , <i>Beggiatoa</i> , many others)
Anaerobic	Purple and green phototrophic bacteria, some chemolithotrophs
<b>Sulfate reduction (anaerobic)</b> ( $\text{SO}_4^{2-} \rightarrow \text{H}_2\text{S}$ )	<i>Desulfovibrio</i> , <i>Desulfobacter</i> ,
<b>Sulfur reduction (anaerobic)</b> ( $\text{S}^0 \rightarrow \text{H}_2\text{S}$ )	<i>Desulfuromonas</i> , many hyperthermophilic <i>Archaea</i>
<b>Sulfur disproportionation</b> ( $\text{S}_2\text{O}_3^{2-} \rightarrow \text{H}_2\text{S} + \text{SO}_4^{2-}$ )	<i>Desulfovibrio</i> , and others
<b>Organic sulfur compound oxidation or reduction</b> ( $\text{CH}_3\text{SH} \rightarrow \text{CO}_2 + \text{H}_2\text{S}$ ) (DMSO $\rightarrow$ DMS)	
<b>Desulfurylation</b> (organic-S $\rightarrow$ $\text{H}_2\text{S}$ )	Many organisms can do this



**Robert D. Ballard**

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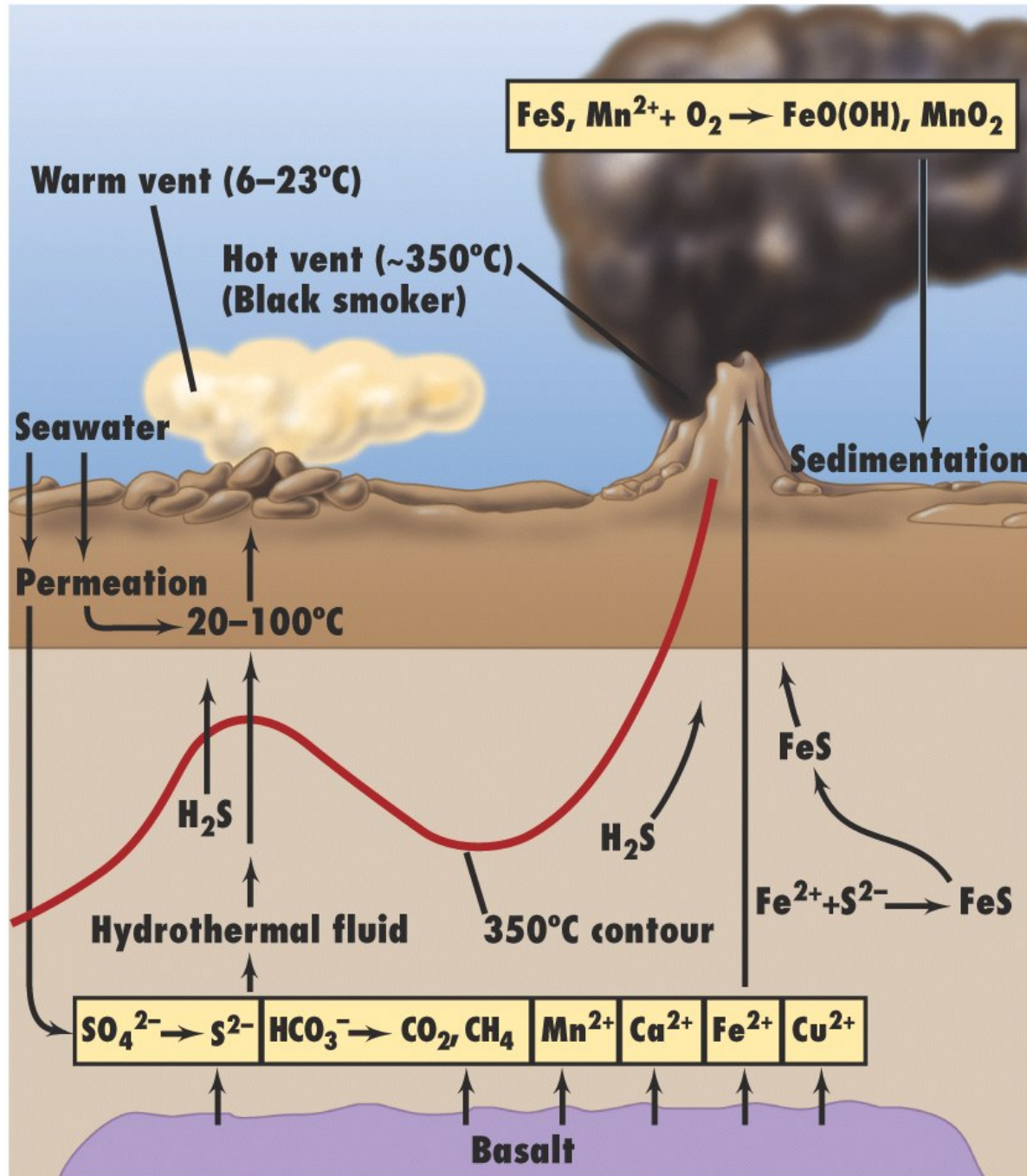
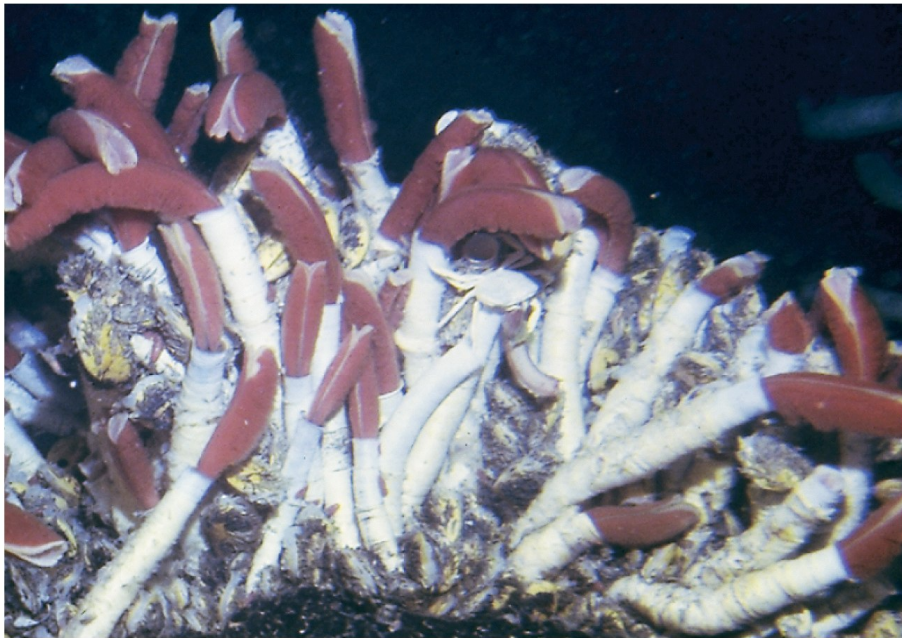
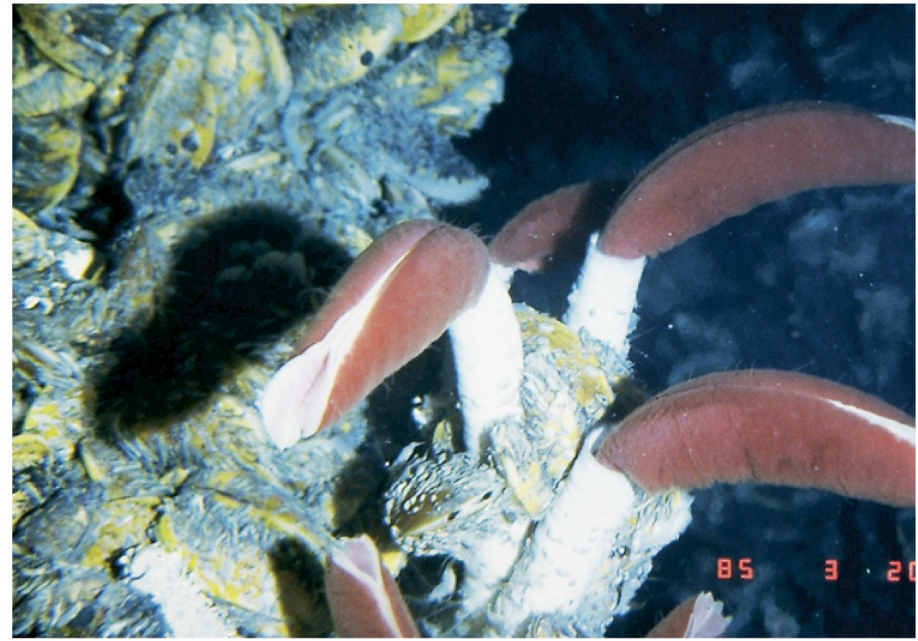


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Dudley Foster, Woods Hole Oceanographic Institution



James Aguiar, Woods Hole Oceanographic Institution

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