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Zinc and Nickel signature for abiogenic and biogenic magnetite

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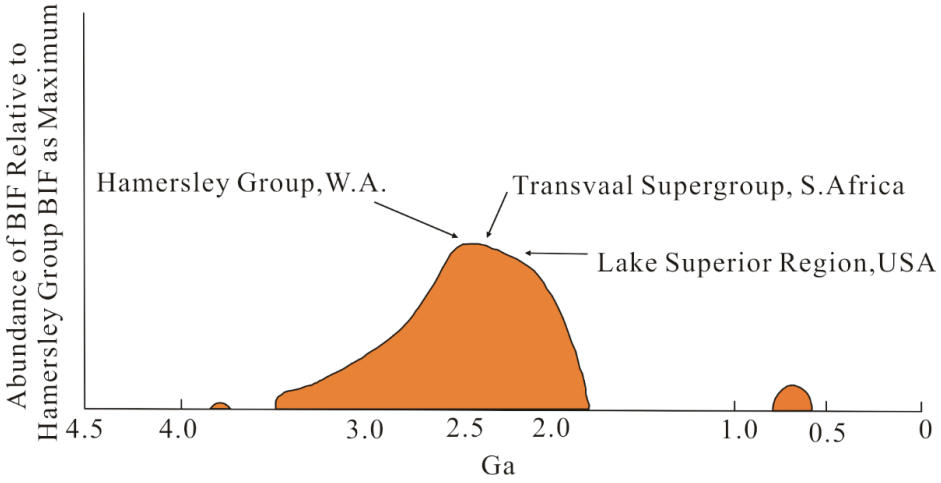
Banded Iron Formations



- Fe-rich (20-40 wt.-%)
- Si-rich (40-50 wt.-% SiO_2)
- Layered sedimentary rocks
- Deposited between 3.8 - 1.85 Ga

(Klein C, 2005)

$Fe^{II}Fe^{III}_3O_4$ - **Magnetite**

$Fe^{III}_2O_3$ - Hematite

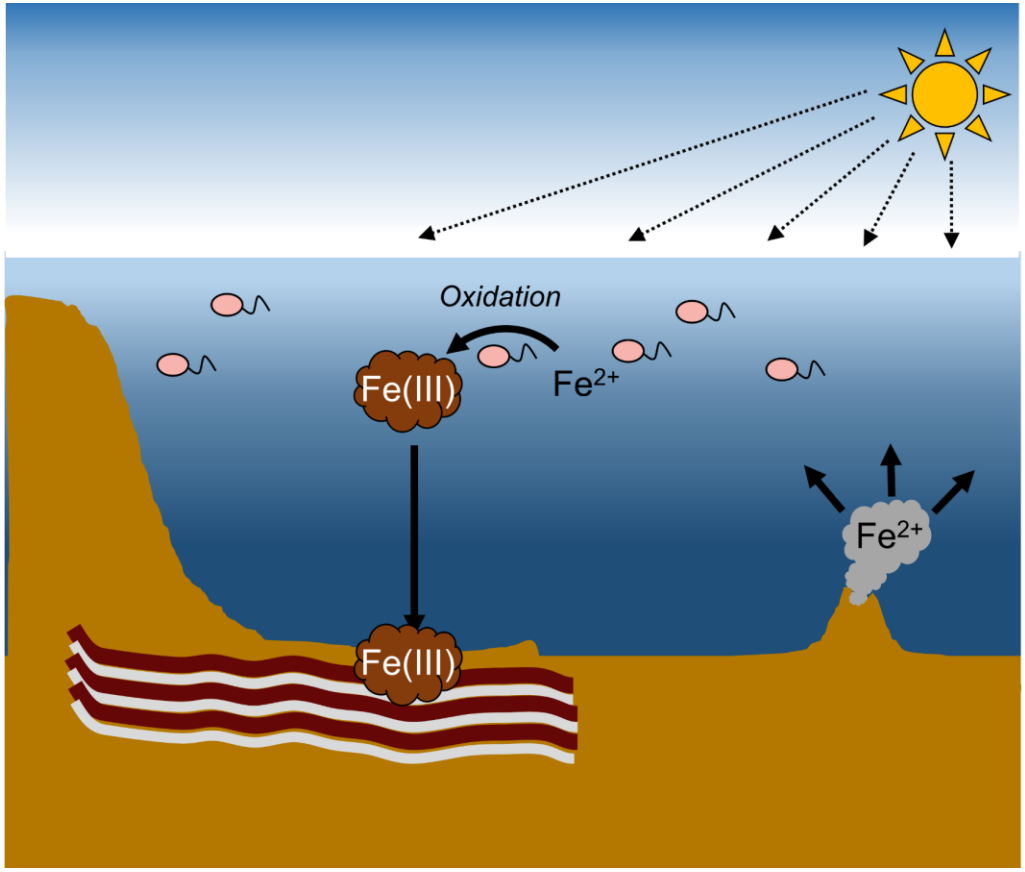
$Fe^{II}CO_3$ - Siderite

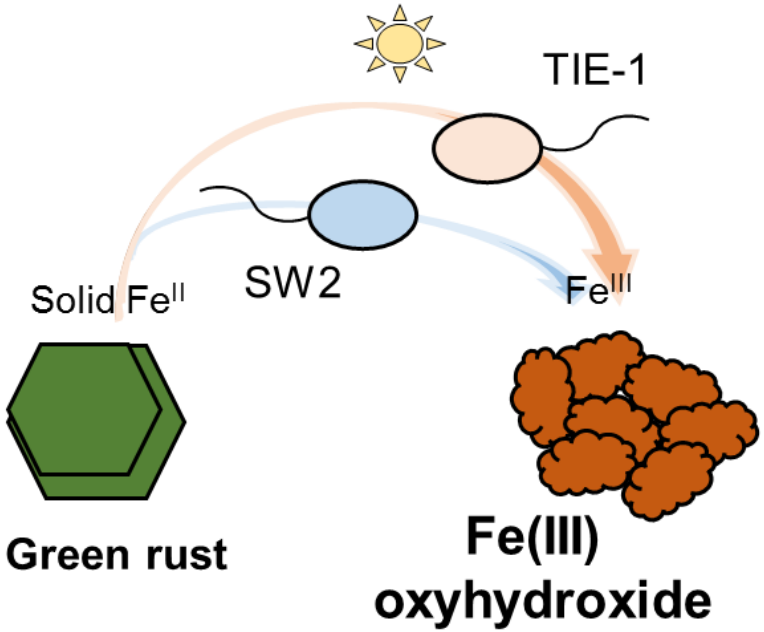
Fe^{II}/Fe^{III} - Silicates

SiO_2 - Chert

($Fe^{II}S_2$ - Pyrite)

Banded Iron Formations



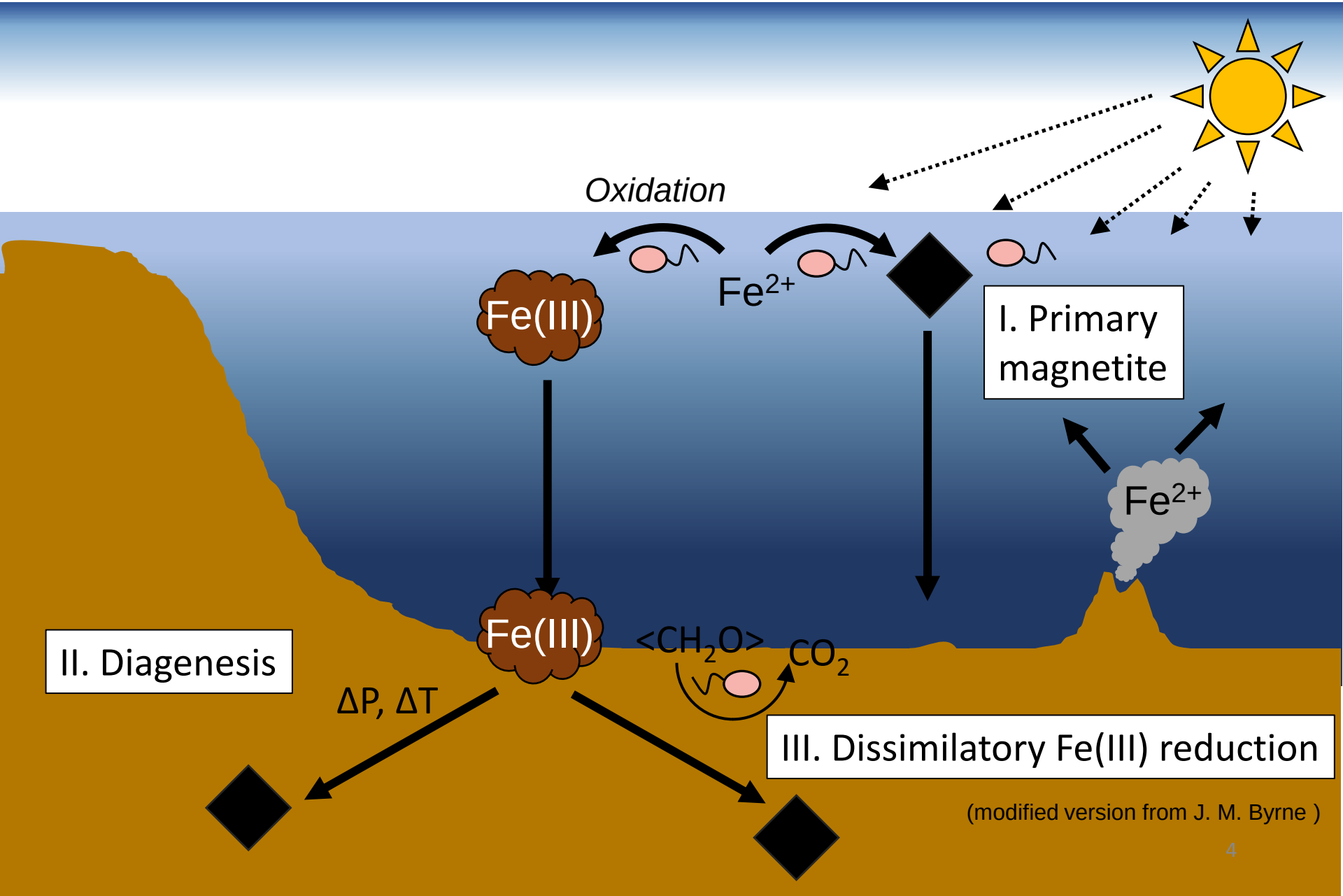


(Han *et al.*, GPL, 2020)

Anoxygenic phototropic Fe(II) oxidation

An important mechanism for Precambrian BIFs deposition in ancient oceans.

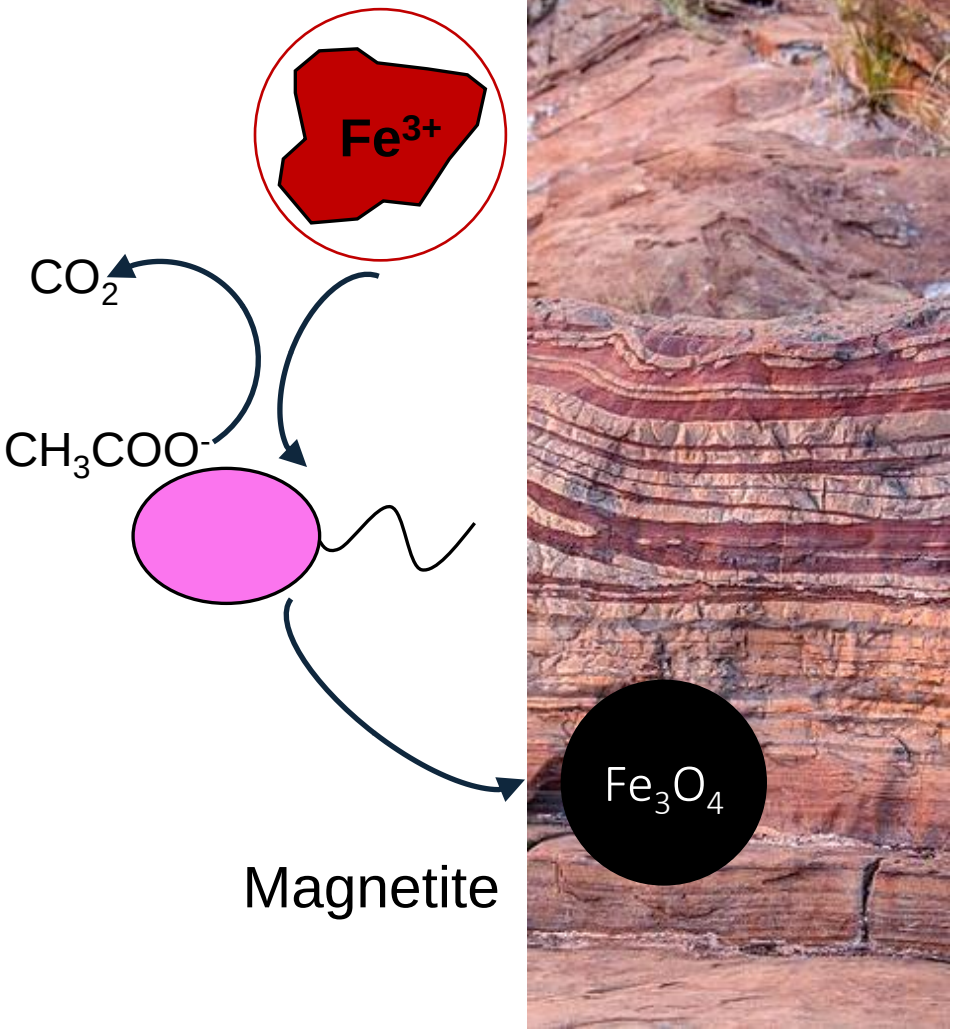
Banded Iron Formations: Magnetite



(modified version from J. M. Byrne)

Evidences for DIR

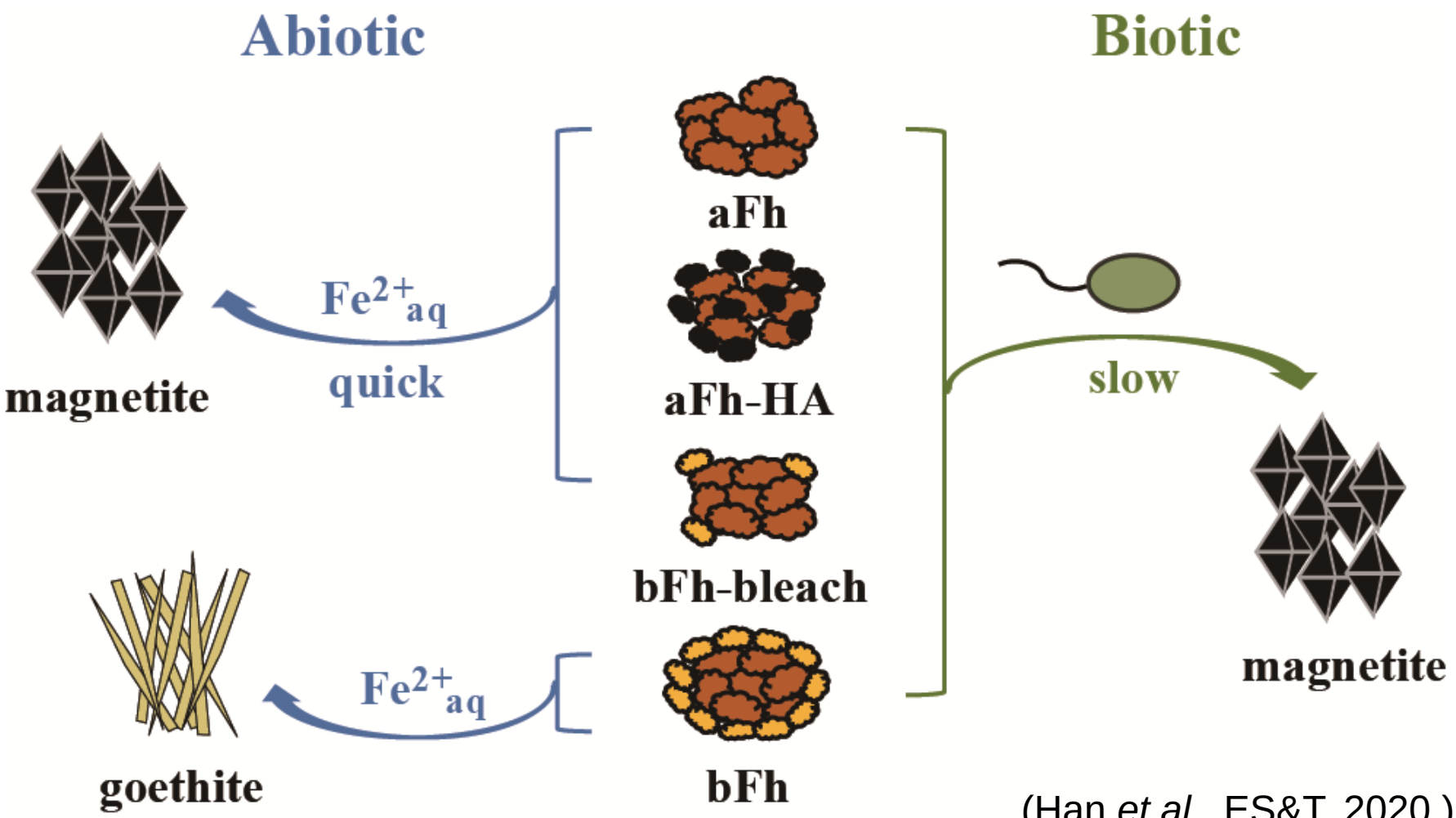
Dissimilatory Fe(III) reduction (DIR)



- An ancient metabolism in the universal phylogenetic tree
- Highly negative $\delta^{56}Fe$ values
- A similar lattice constant and Fe^{2+}/Fe^{3+} stoichiometry
- Pure chemical compositions
- Simulation experiments

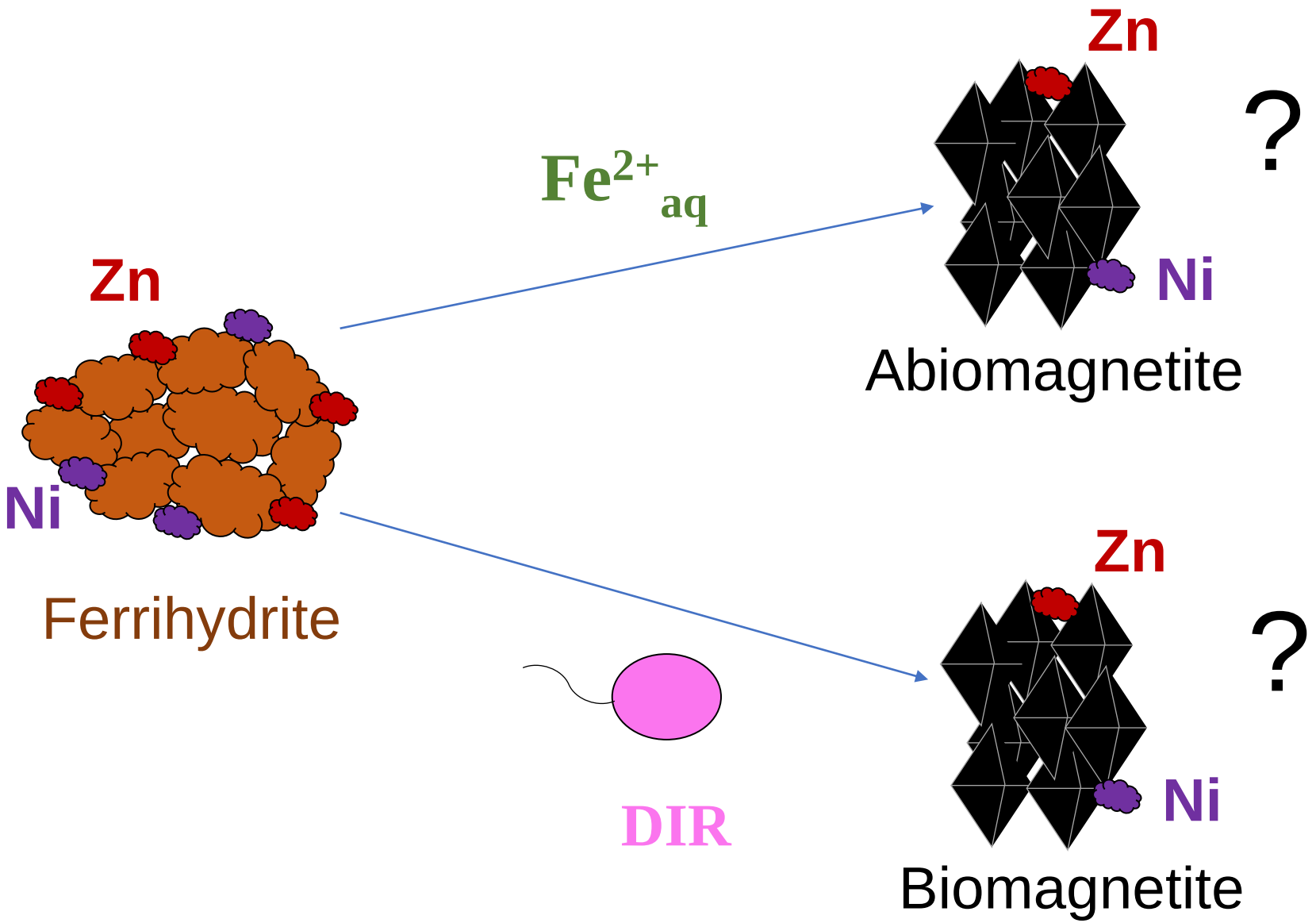
(Yi-Liang Li *et al*., 2017)

Abiotic vs Biotic



(Han *et al.,* ES&T, 2020)

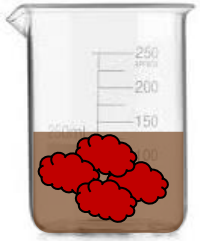
Potential signature?



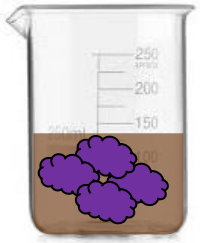
Ferrihydrite syntheses

Control Fh

$Fe(NO_3)_3*9H_2O$
KOH

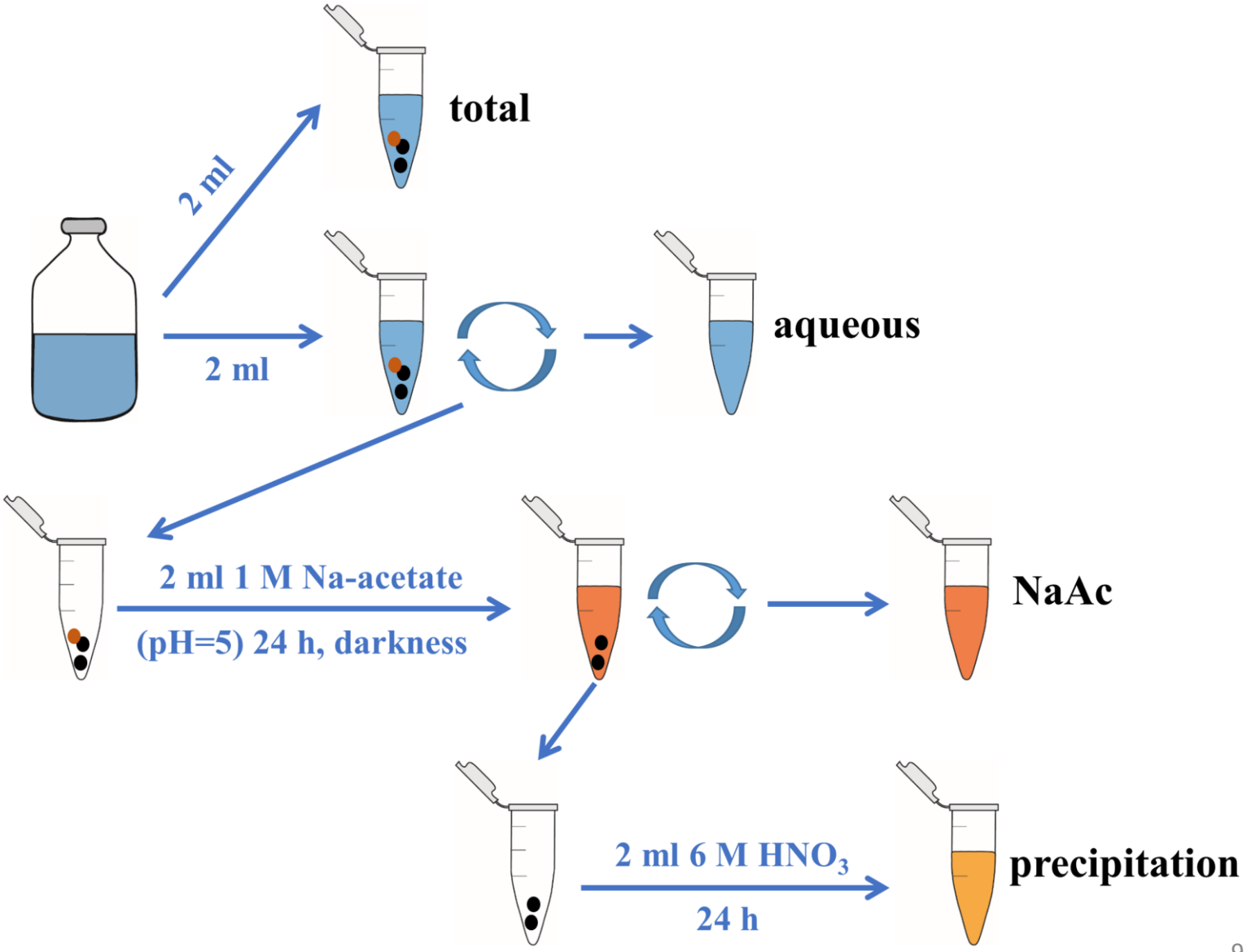


Fh with Zn



Fh with Ni

Sequential extraction



Conclusions

1. **Abiogenic magnetite** was produced from reaction between Fe^{2+}_{aq} and ferrihydrite
2. **Biogenic magnetite** was produced from transformation of ferrihydrite by Fe(III)-reducing bacteria *S. oneidensis* MR-1.
3. NaAc extraction removed **siderite** from transformation products.
4. Both Zn and Ni were much more **depleted** in abiogenic magnetite than those in biogenic magnetite.
5. Trace element distribution could be a chemical **signature** to distinguish biogenic from abiogenic magnetite in BIFs.

Acknowledgements

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