EGU General Assembly
Vienna, Austria & Online, 23–27 May 2022

Formation of deep hydrothermal vein-type Mo greisen and base metal mineralization at the Sweet Home mine, Colorado (USA)

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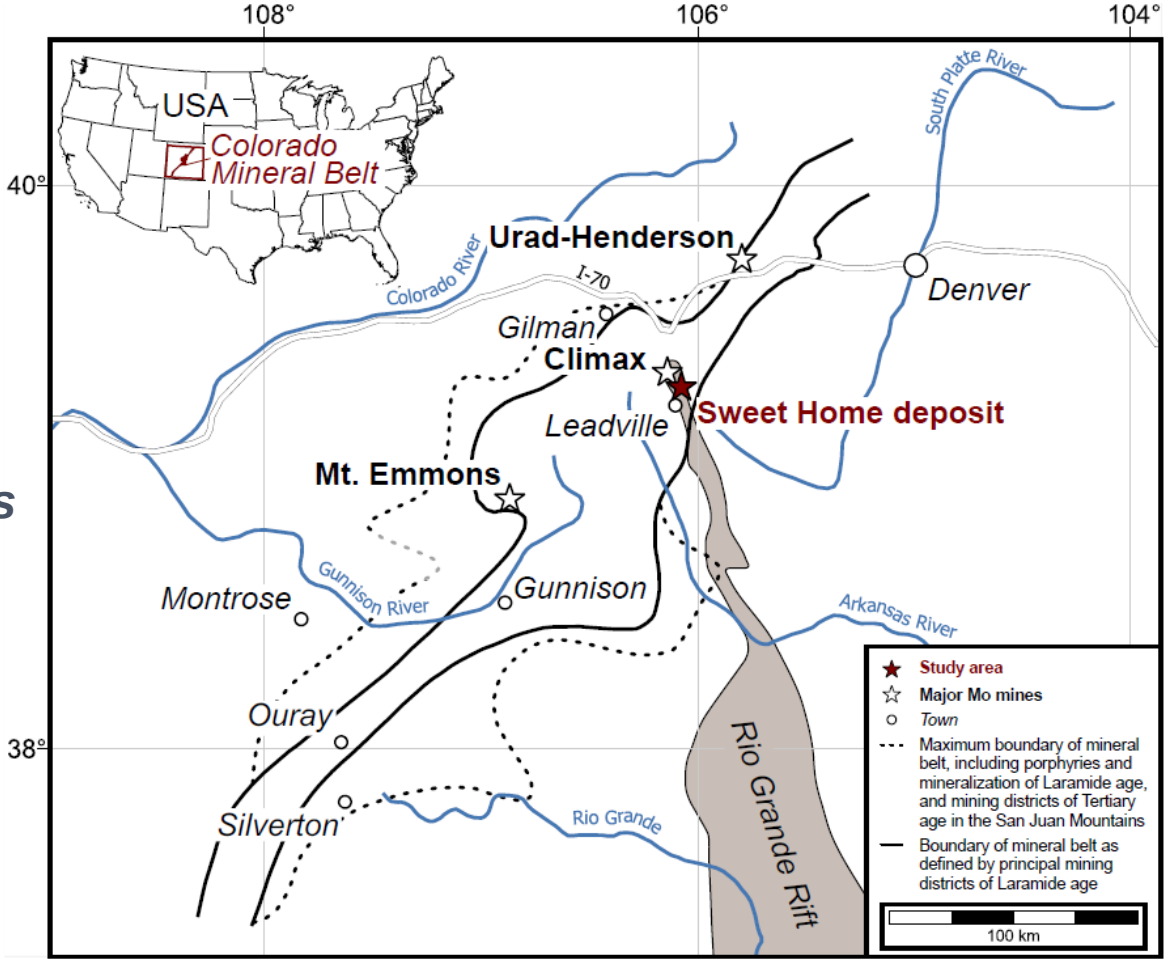
Introduction

Colorado Mineral Belt

- *Metallogenic province extending 400 km throughout Colorado*
- *At 33 Ma opening of the Rio Grande Rift accompanied by bimodal magmatism*
- ***Climax-type Mo porphyry deposits***

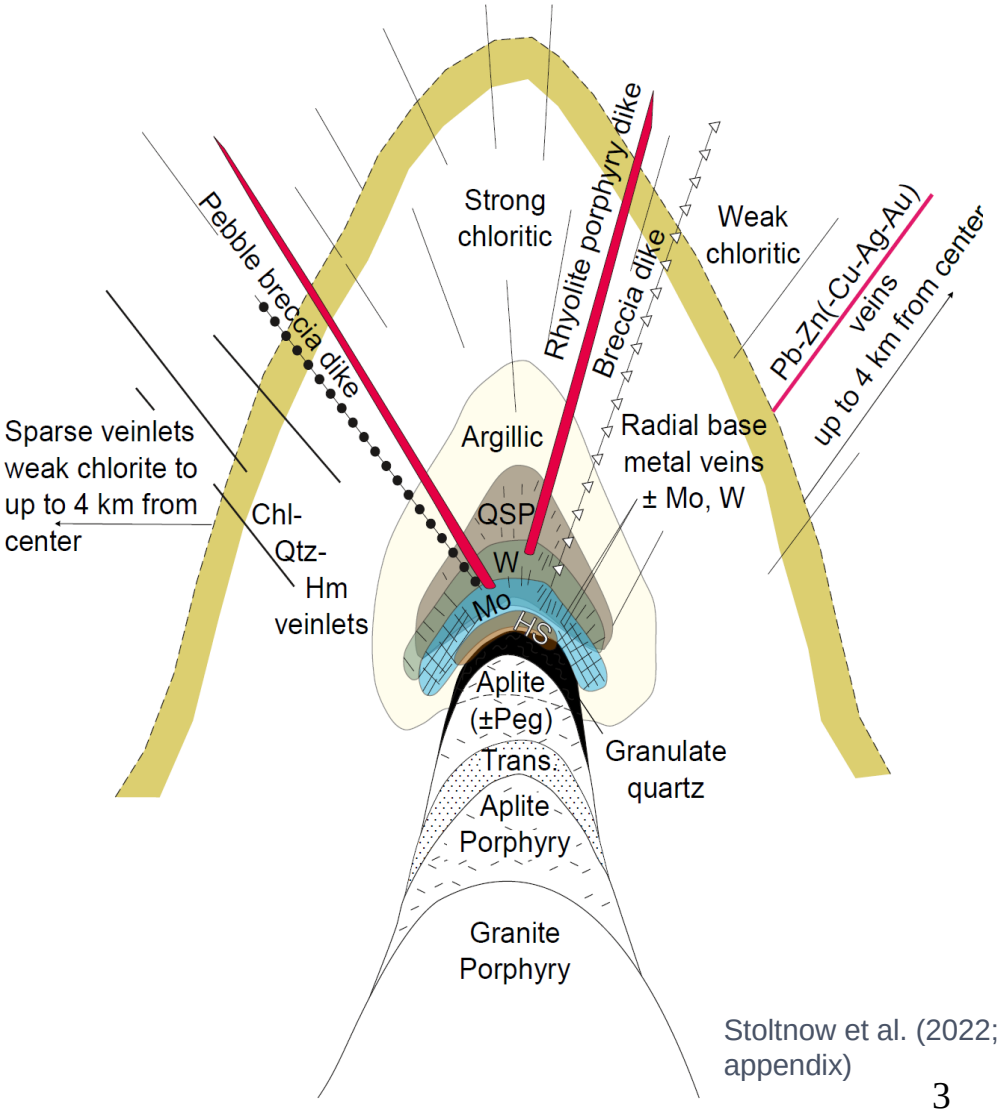


Stoltnow et al. (2022)

Introduction

Climax-type deposits

- *high Mo but little Cu enrichment*
- *Mo-Qtz stockwork and Mo-Fl-Qtz-Py-W greisen ore shells*
- *Peripheral base metal-rhodochrosite veins*



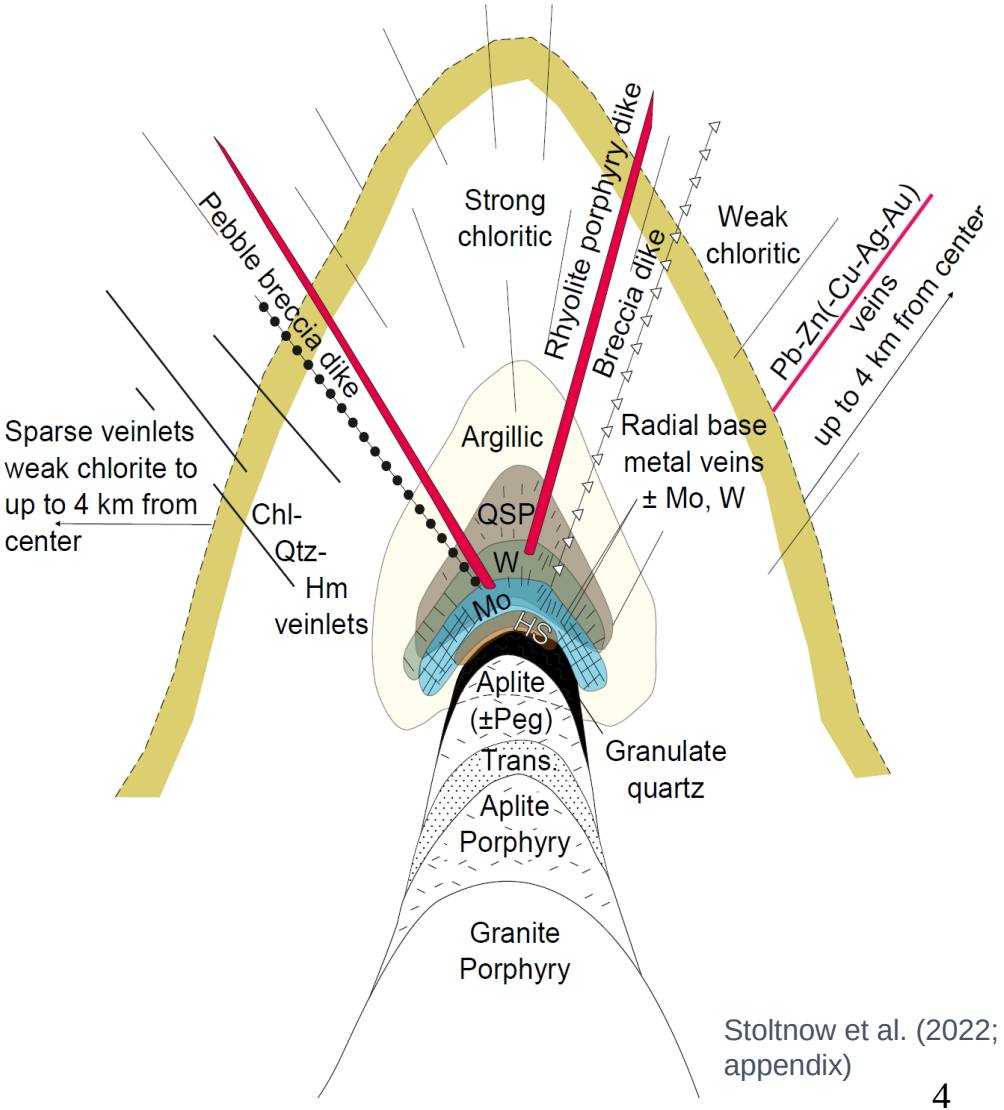
Stoltnow et al. (2022; appendix)

Introduction

Magmatic vs. meteoric origin of fluids, metals and volatiles

Magmatic origin:

- *For all stages incl. peripheral veins*
- *Fluids → rhyolitic melts*
- *Metals → mantle + partial melting of country rocks*
- *Volatiles → Mantle and/or rhyolitic melt*



Stoltnow et al. (2022; appendix)

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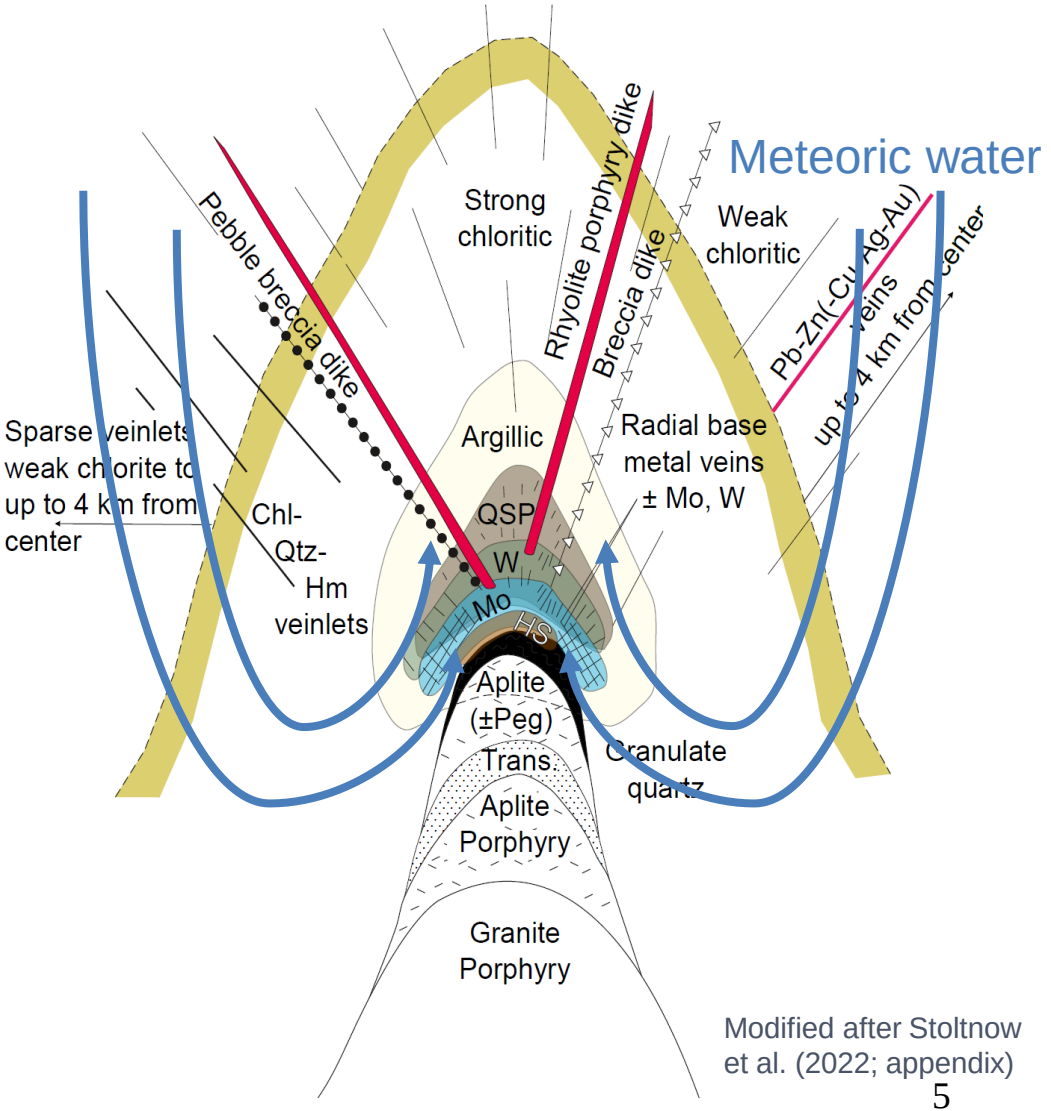
vs.

Meteoric origin:

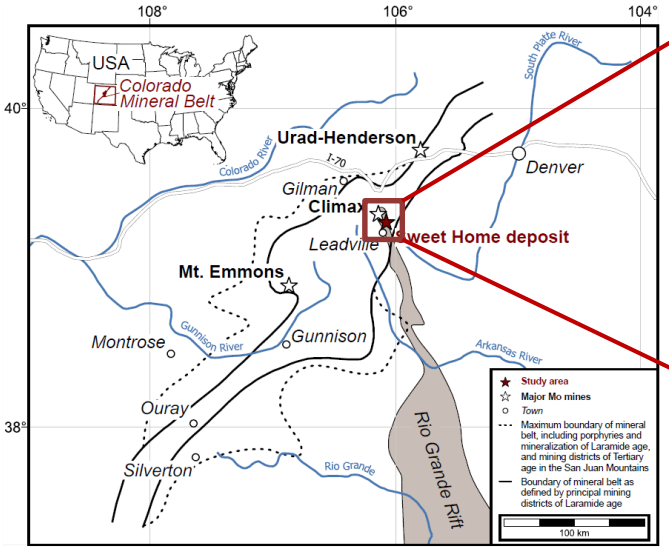
- *Large-scale convection of non-magmatic fluids may lead to effective leaching of metals from the country rocks*



Modified after Stoltnow et al. (2022; appendix)

Introduction

Sweet Home/Climax connection



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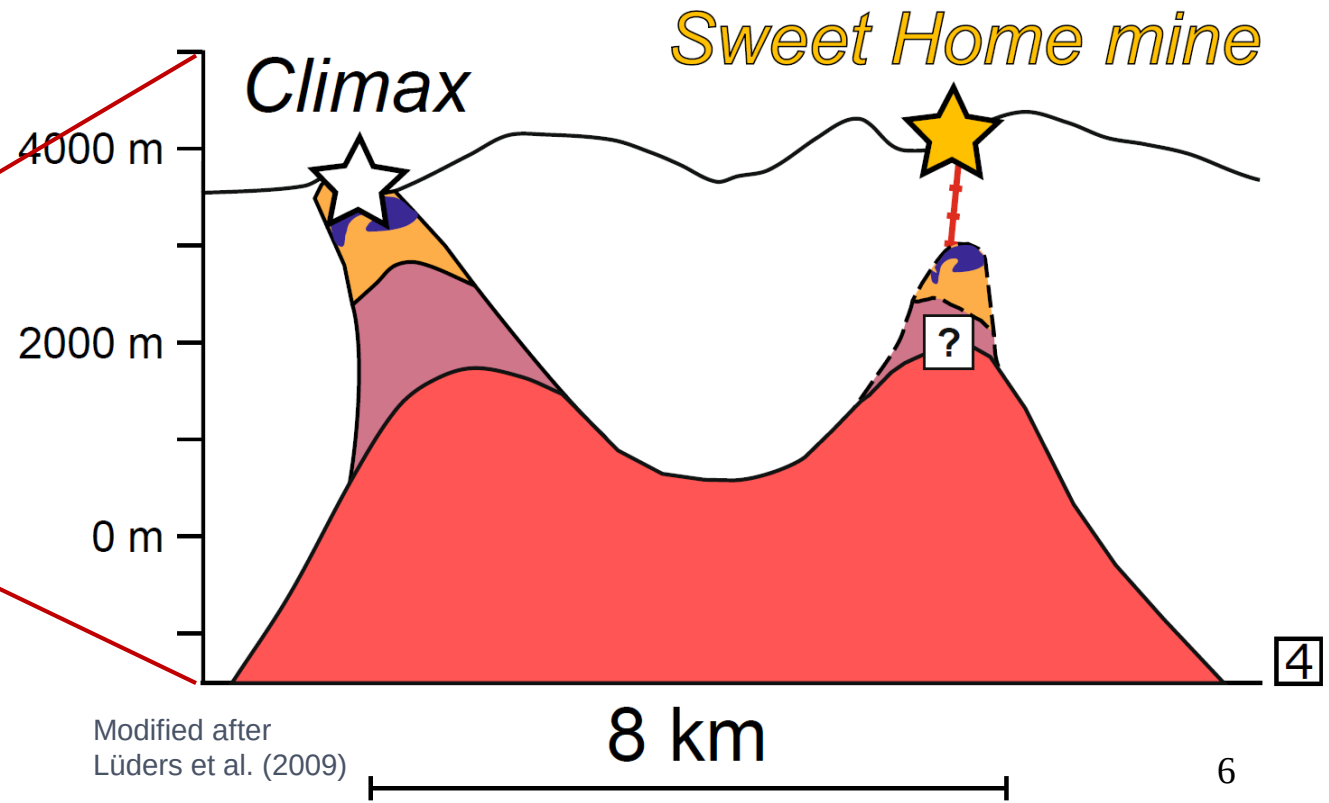


Modified after
Lüders et al. (2009)

Introduction

Sweet Home/Climax connection

- *Similar Mo-W greisen and base metal sulfide-rhodochrosite vein mineralization*
- *Since **2017** abundant Mo discoveries*

Photo taken by Malte Stoltnow

Photo taken by Dean Misantoni

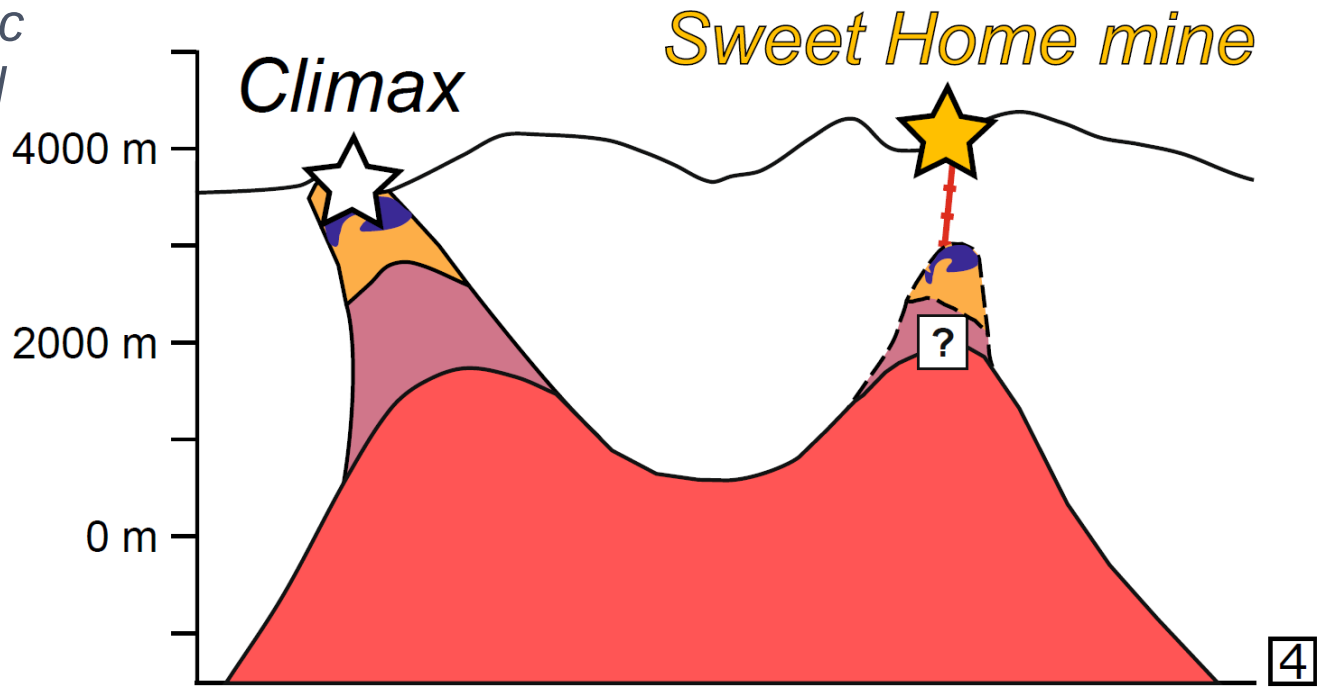
Stoltnow et al. (2022)

Photo taken by Malte Stoltnow

Introduction

Evolution of the Sweet Home mine

- *Ore fluid circulation triggered by a hidden porphyry and mixing of magmatic fluids and meteoric water formed the base metal sulfide-rhodochrosite stage*



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Lüders et al. (2009)

Introduction

Evolution of the Sweet Home mine

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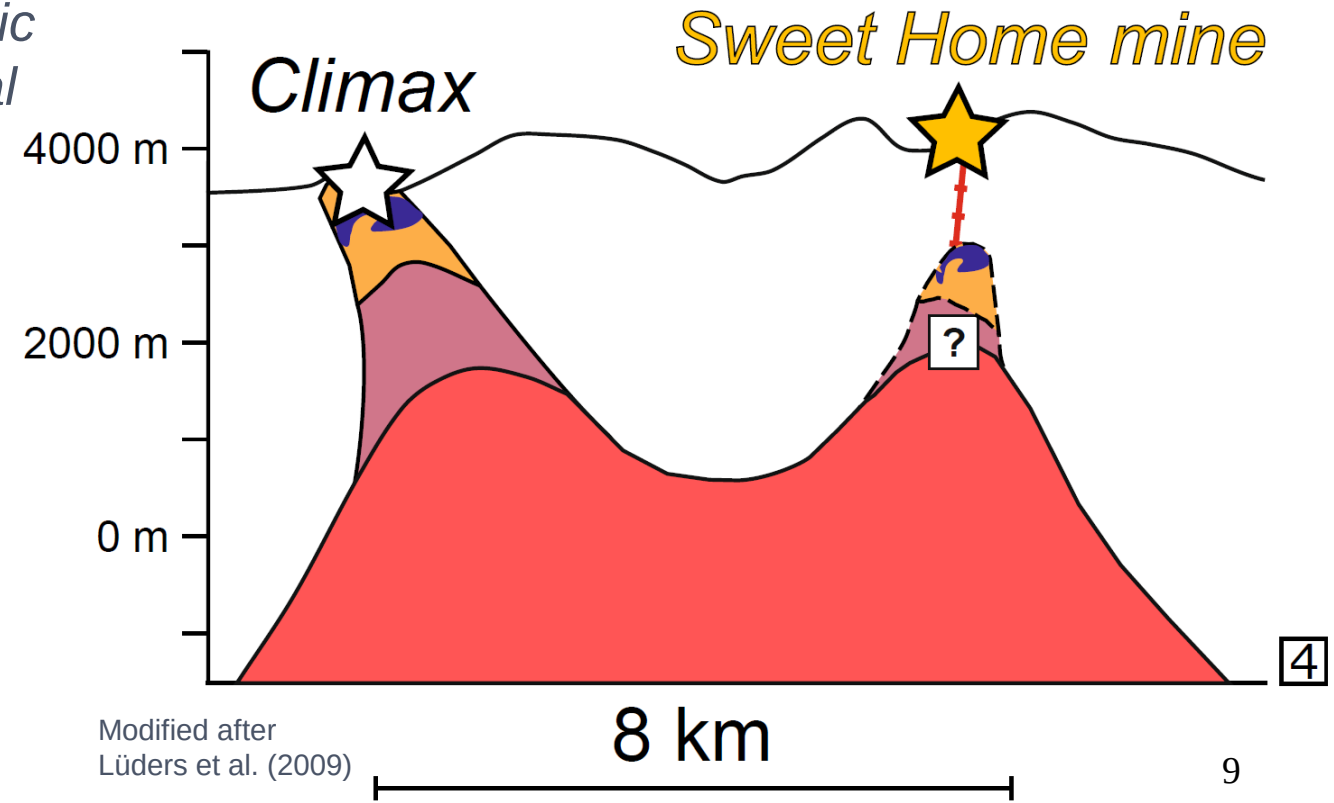
Motivation

- *What formed the earlier Mo-W mineralization?*



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Lüders et al. (2009)

Microthermometry
Raman spectroscopy

Methods

Microthermometry

Raman spectroscopy

$\delta^{13}C$ $\delta^{18}O$

$\delta^{2}H$

Methods

Microthermometry

Raman spectroscopy

$\delta^{13}C$ $\delta^{18}O$

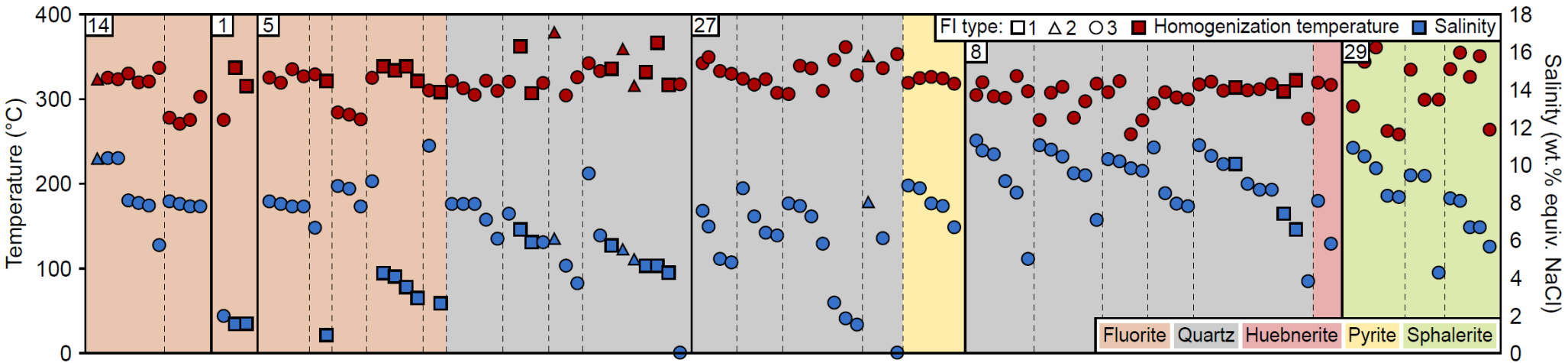
$\delta^{2}H$

He, Ne, Ar,
Kr, Xe

Results

Fluid inclusion microthermometry and Raman spectroscopy

- *1.5-11.5 wt.% equiv. NaCl*
- *CO_2-bearing fluids*
- *T_H ~ 320°C*
- *Trapping temperatures >350°C*

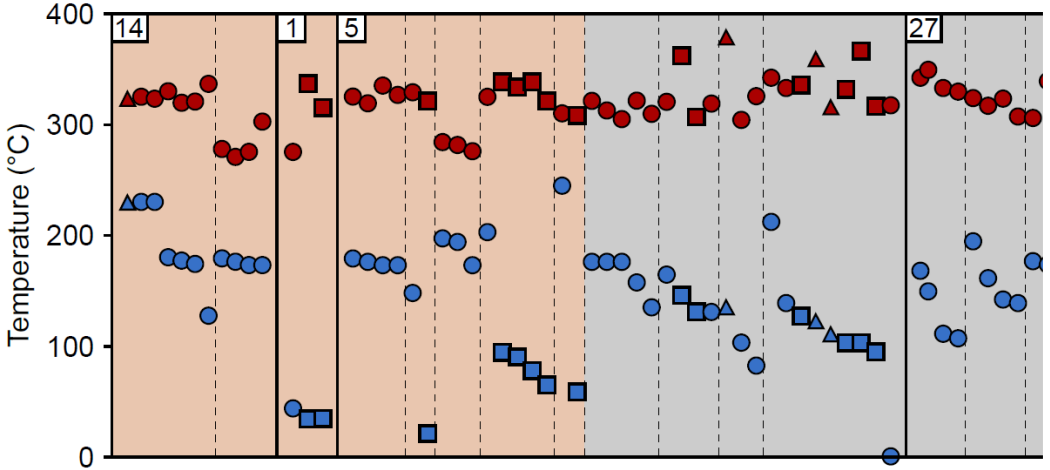


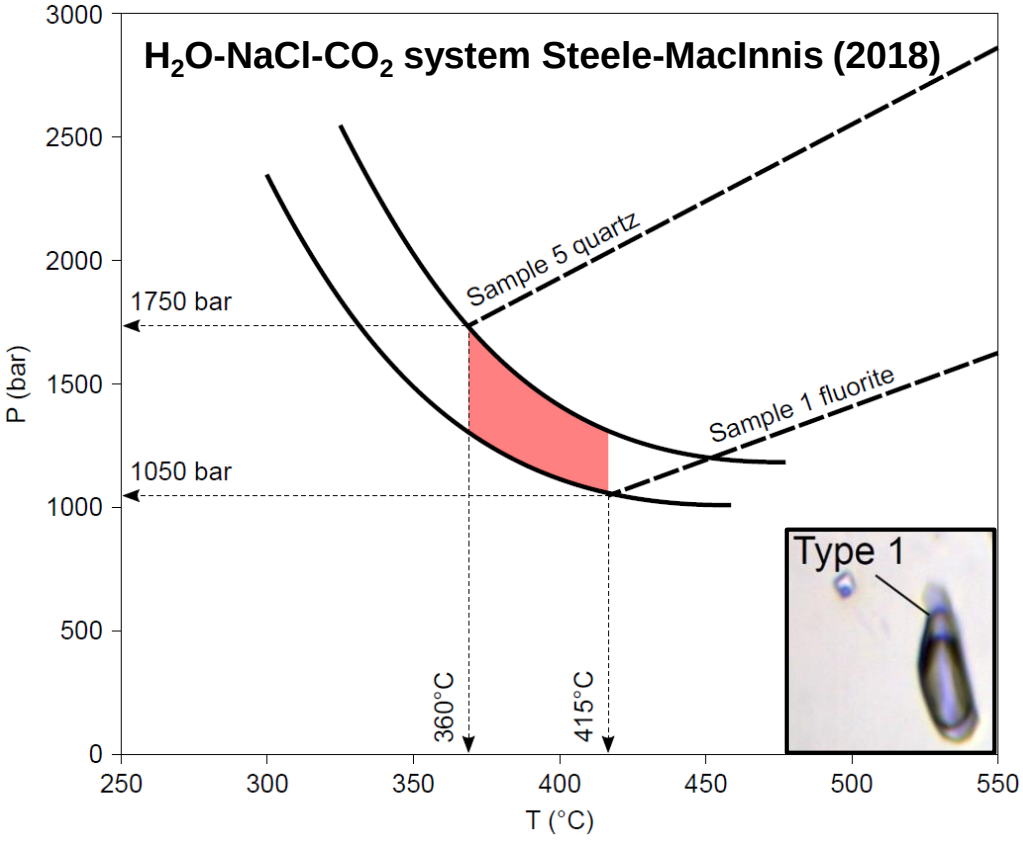
Stoltnow et al. (2022)

Results

Fluid inclusion P-T trapping conditions

- T_H ~ 320°C
- Trapping temperatures >350°C
- Depth of formation > 3 km



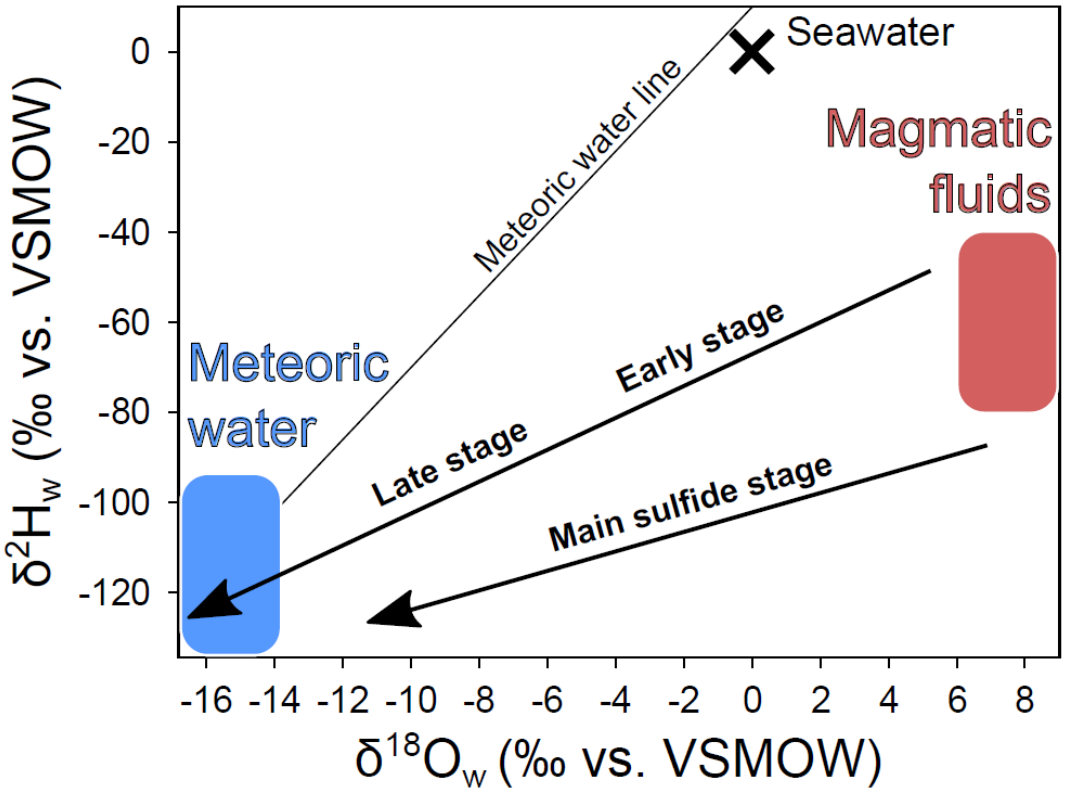


Stoltnow et al. (2022)

Results

Fluid inclusion hydrogen and oxygen isotopic composition

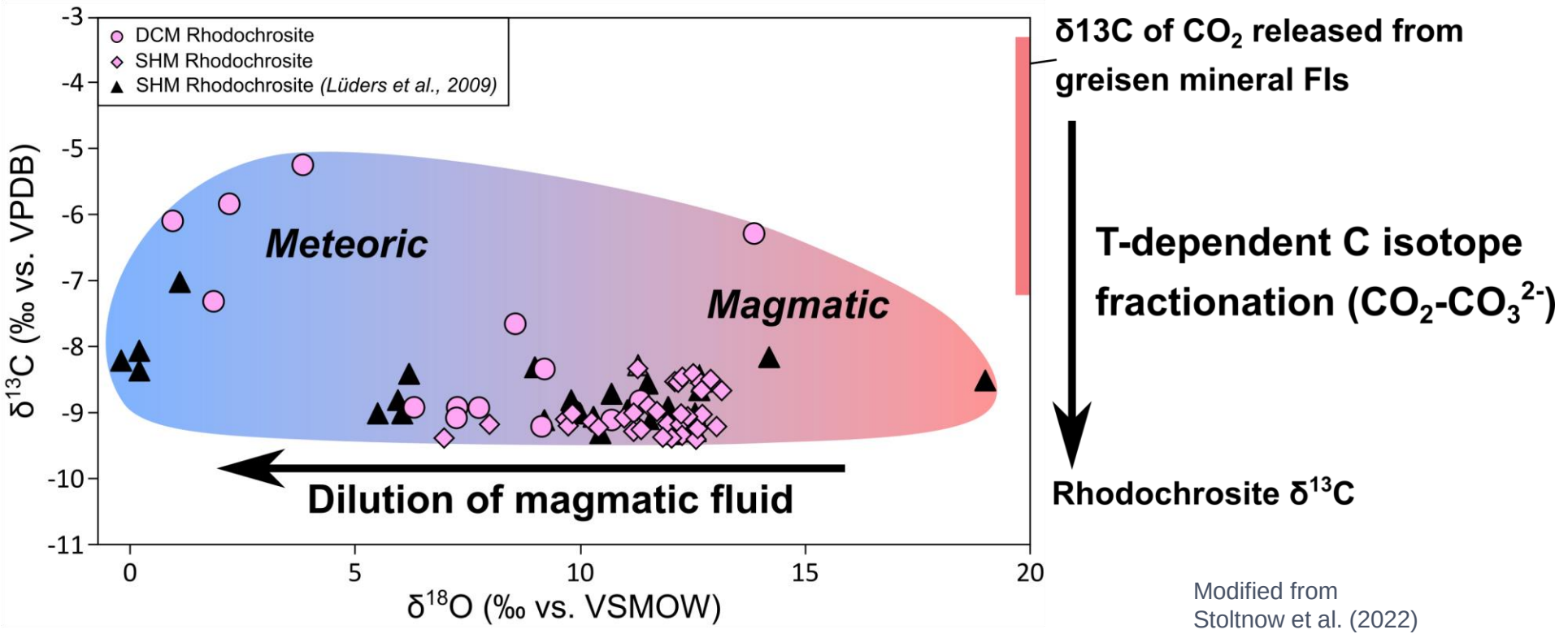
- *Analysis of ore and gangue minerals of all stages*
- *Two mixing trends between magmatic and meteoric water reservoirs*



Modified from Stoltnow et al. (2022)

Results $\delta^{13}C_{CO2}$ of FI gas and $\delta^{13}C$ and $\delta^{18}O$ of rhodochrosite

- *Trend from early magmatic to later meteoric oxygen signature*
- *rather narrow carbon isotope signature indicates magmatic source throughout the stages*

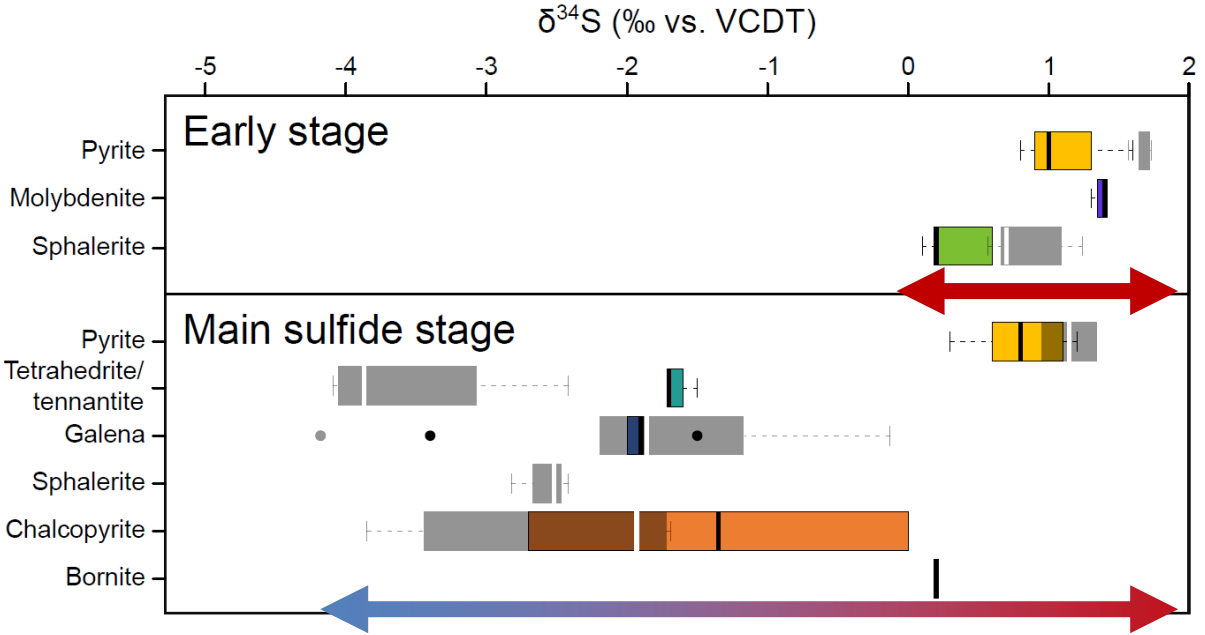


Modified from Stoltnow et al. (2022)

Results

Sulfur isotopic composition

- *Early stage: homogeneous sulfur source*
- *Main sulfide stage: Mixed magmatic-external sulfur source*

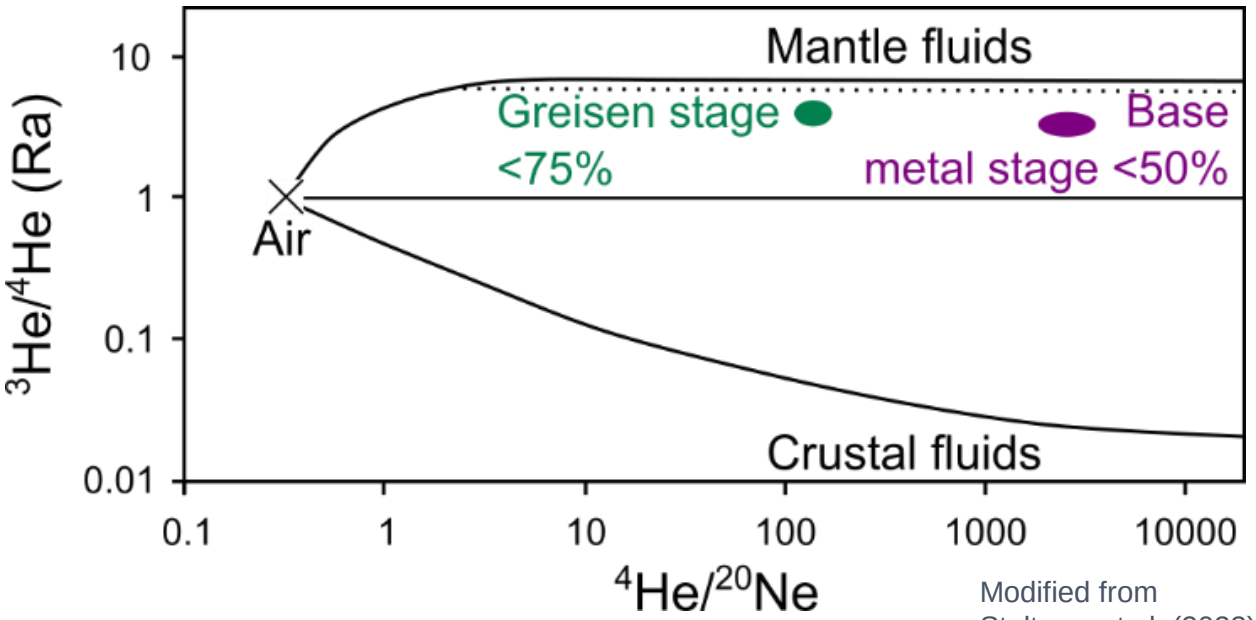


Stoltnow et al. (2022)

Results

Helium and Neon isotopic compositions

- *Non-atmospheric He contribution:*
  - *Mantle reservoir*
  - *Terrestrial reservoir*



Modified from Stoltnow et al. (2022)

Summary and conclusions

- *Fluid system developed from minor magmatic to meteoric water-dominated*
- *Mo-W-greisen mineralization likely formed from hot magmatic-dominated fluids at T >350°C*
- *Magmatic input ≈ mantle input: volatiles (CO_2, H_2S, noble gases); metals?*

Further reading

Mineralium Deposita (2022) 57:801–825
https://doi.org/10.1007/s00126-022-01102-6

ARTICLE

A geochemical study of the Sweet Home mine, Colorado Mineral Belt, USA: formation of deep hydrothermal vein–type molybdenum greisen and base metal mineralization

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Received: 22 September 2021 / Accepted: 16 February 2022 / Published online: 1 March 2022

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Danke! Thank you!

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Youtube - Channel: Gemstones: “Rhodochrosite Mine Tour!!”