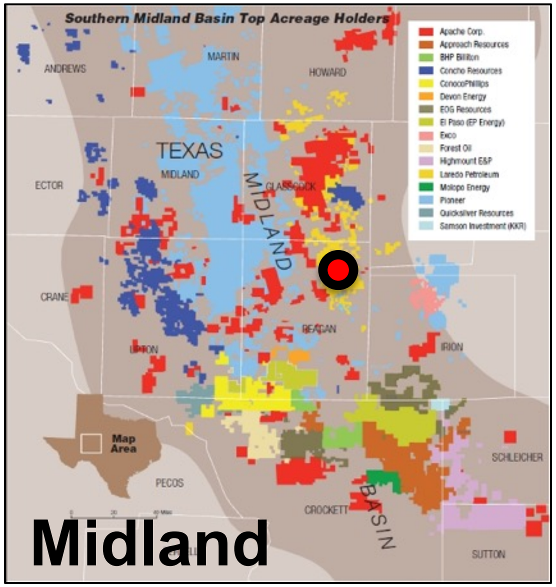
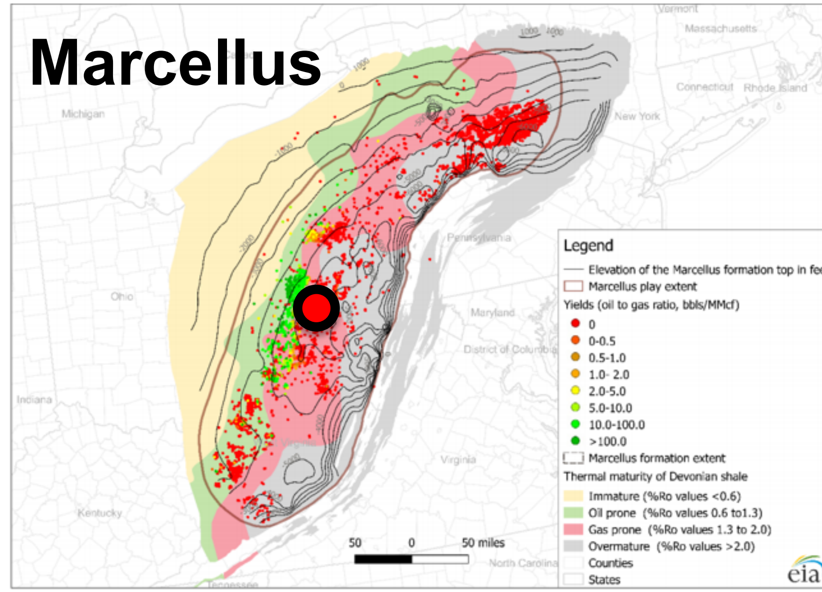
SLAC NATIONAL ACCELERATOR LABORATORY





Basin-specific geochemistry to promote unconventional efficiency

FUNDAMENTAL RESEARCH PROJECT REVIEW MEETING

October 16, 2020

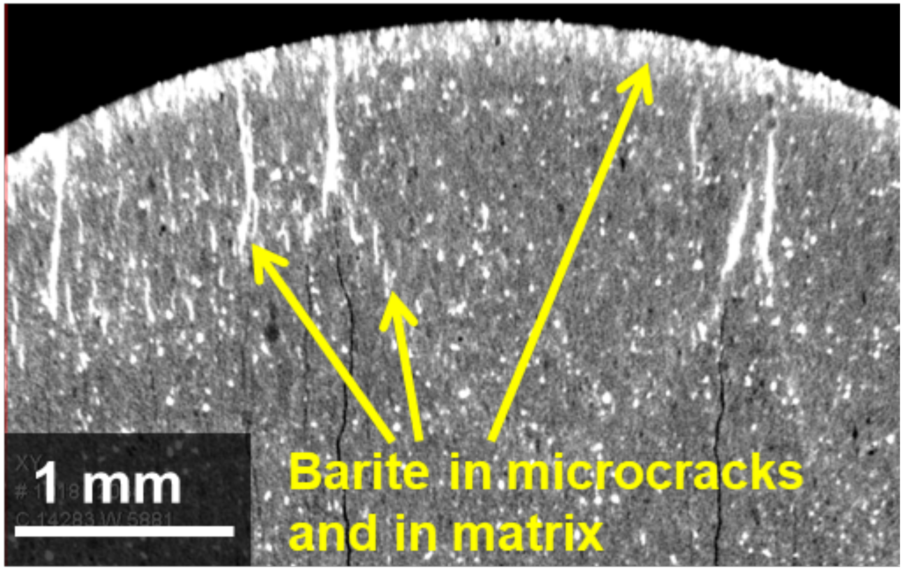
U.S. DEPARTMENT OF ENERGY Fossil Energy OFFICE OF OIL & NATURAL GAS

Address barriers to production: geochemistry

1. Precipitation of mineral scale that clogs fracture faces & (micro-)fractures

2. Unfavorable composition of (recycled) water and brine used for stimulation

3. *Very* low intrinsic permeability



Important knowledge gaps

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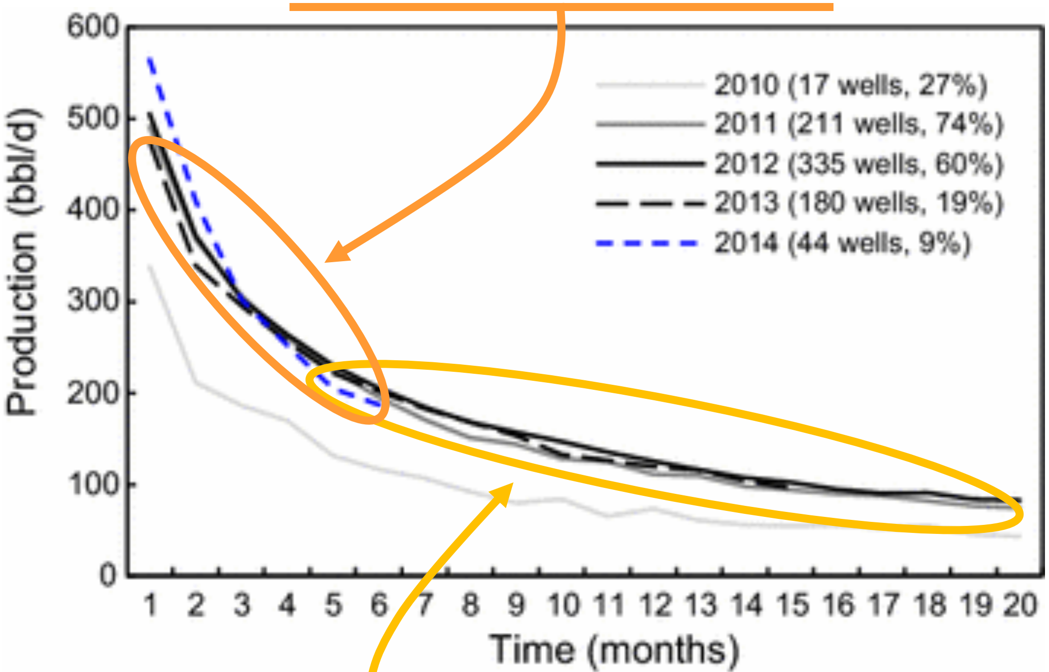
What geochemical parameters control mineral scale - in different basins?

Can we monitor mineral scale and fractures simultaneously?

How can we mitigate unconventional mineral scale?



Wachtmeister *et al* (2017) *Nat. Resour.Res*

Can we manipulate porosity to improve flow through fracture faces?

Goal: Develop and embed shale-fluid geochemical knowledge in literature and industrial best practices

SLAC

Progress →

Basins

Develop basin-specific geochemical fluid-shale reaction models

- Marcellus Basin
- Wolfcamp & Permian Basin — *in progress*
- Bakken Formation
- Tuscaloosa shale

Fluid composition

Basin-specific fluid optimization for scale management

- CT imaging of dynamic porosity/perm evolution
- Sulfate mineral scale — *in progress*
- Acid concentration
- Iron control
- Cross-linkers

Model development

Improve shale-fluid reactive transport model capabilities

- Reaction networks, rates
- Chemistry + reactive locations
- Sensitivity analysis — *in progress*
- Link porosity to permeability

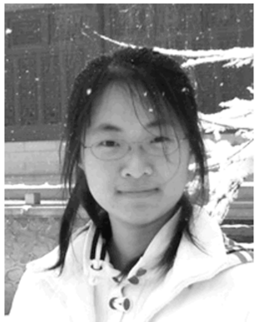
Upscaling

Implement geochemical knowledge at scale

- Seismic monitoring of porosity evolution
- HFTS test project LBL, LLNL, SLAC, NETL — *in progress*
- Develop seismic rock physics model
- Reservoir-scale seismic monitoring of porosity alteration
- Reservoir management LANL collaboration

Team

Li



Geochemical modeling

Spielman-Sun

Experimental geochemistry

Ding

Rock physics

Clark

Rock physics

Gundogar

Fluid transport

Noël

Experimental geochemistry

Bargar

Experimental geochemistry

Jew

Experimental geochemistry

Druhan

Geochemical modeling

Kovscek

Fluid transport

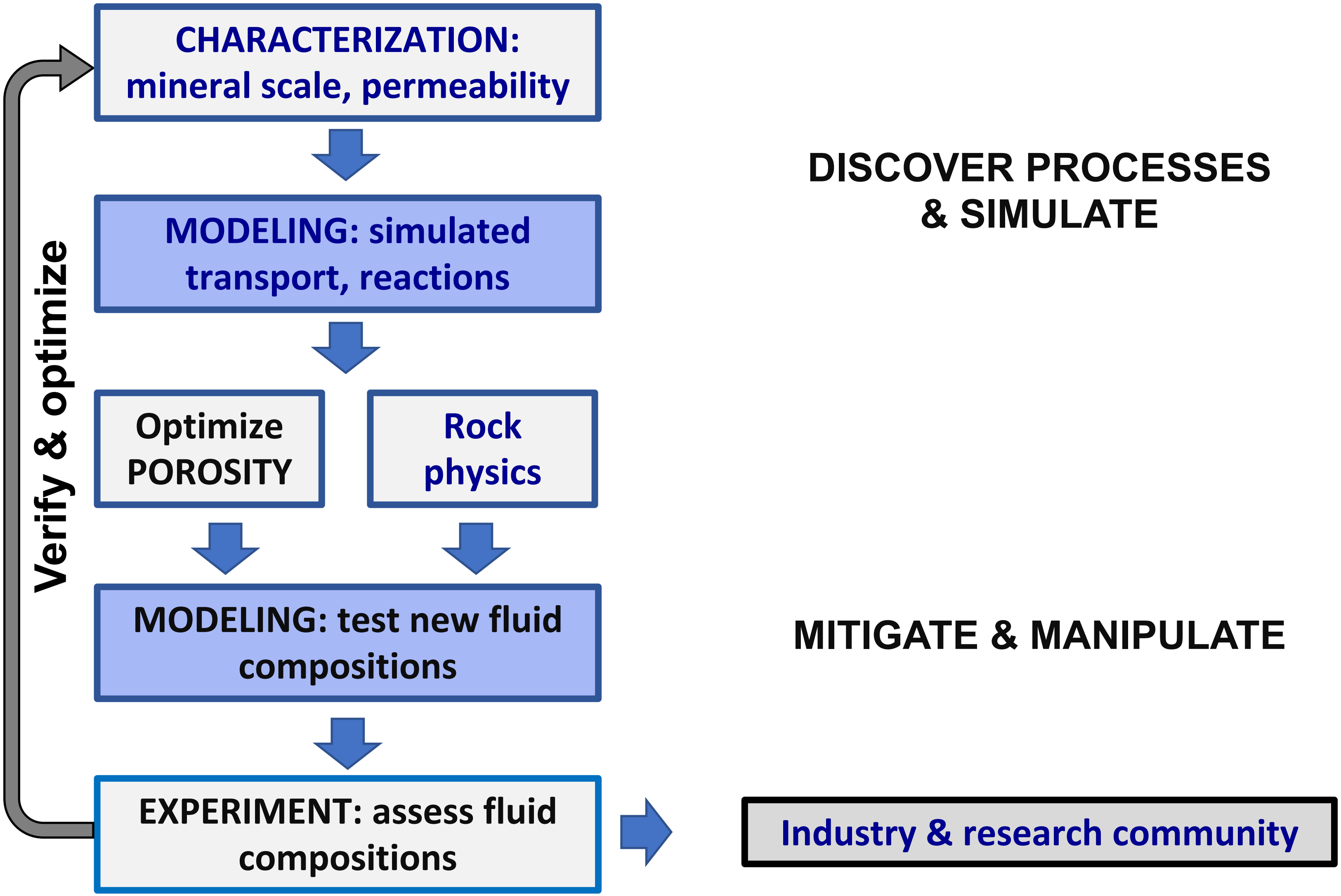
Vanorio

Rock physics

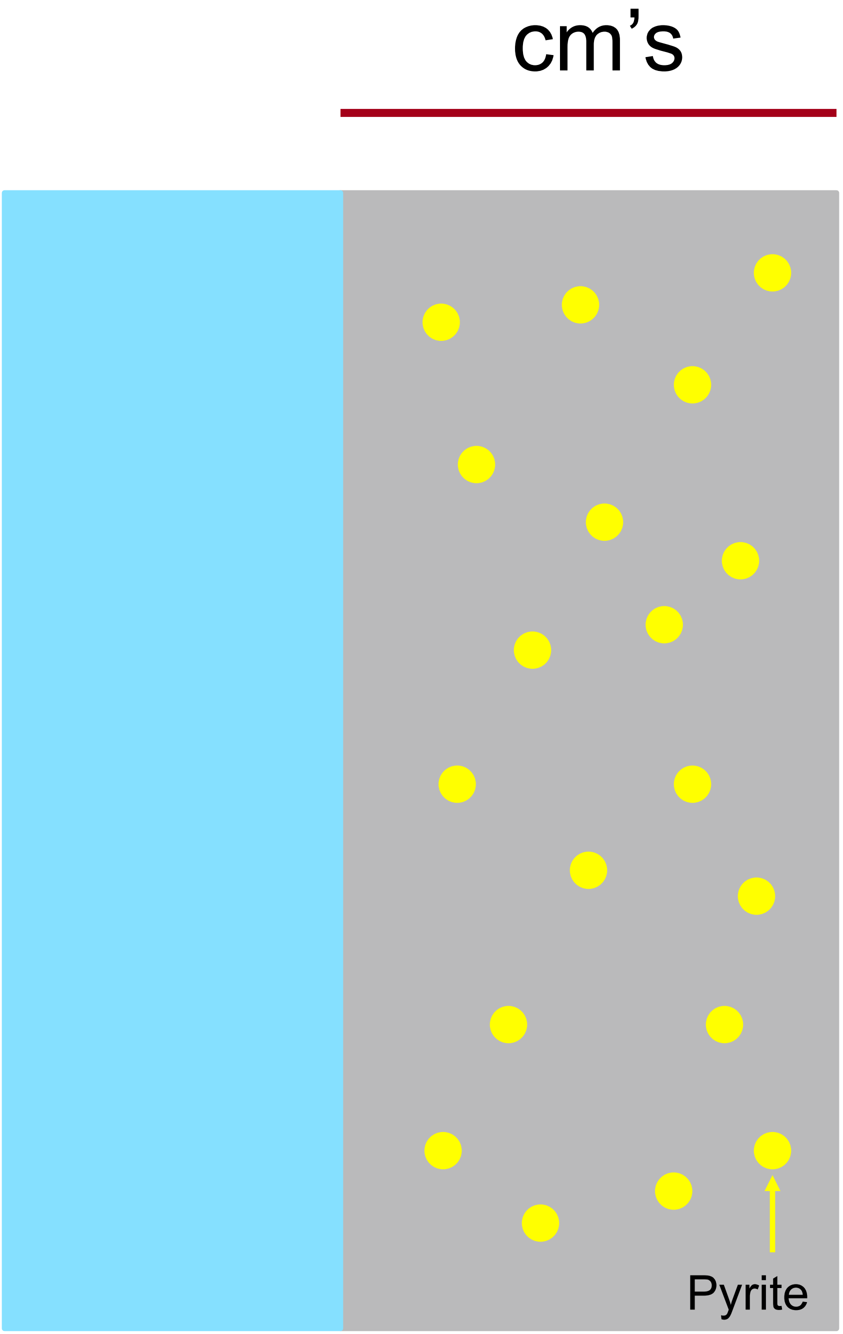
Brown

Experimental geochemistry

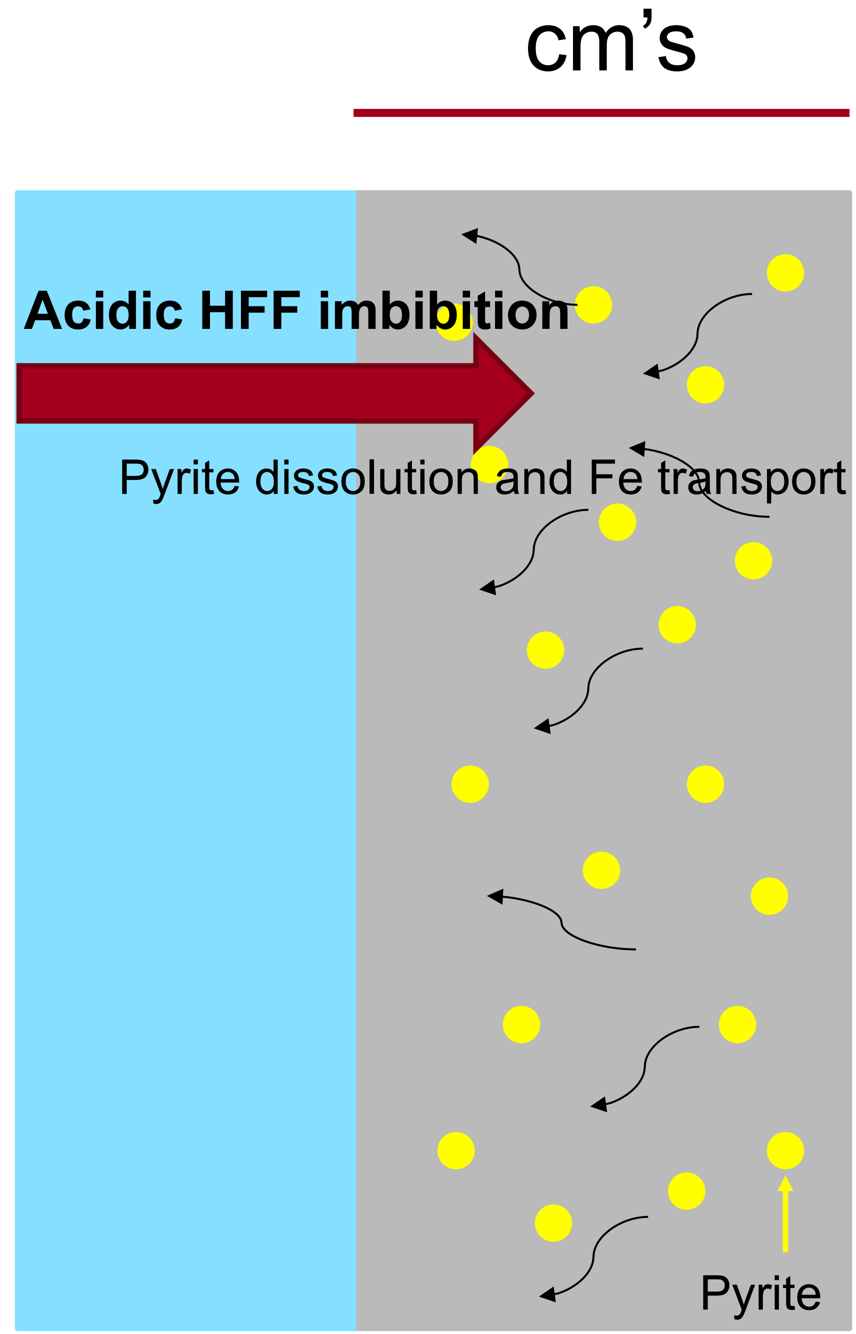
Understand and Mitigate Mineral Scale



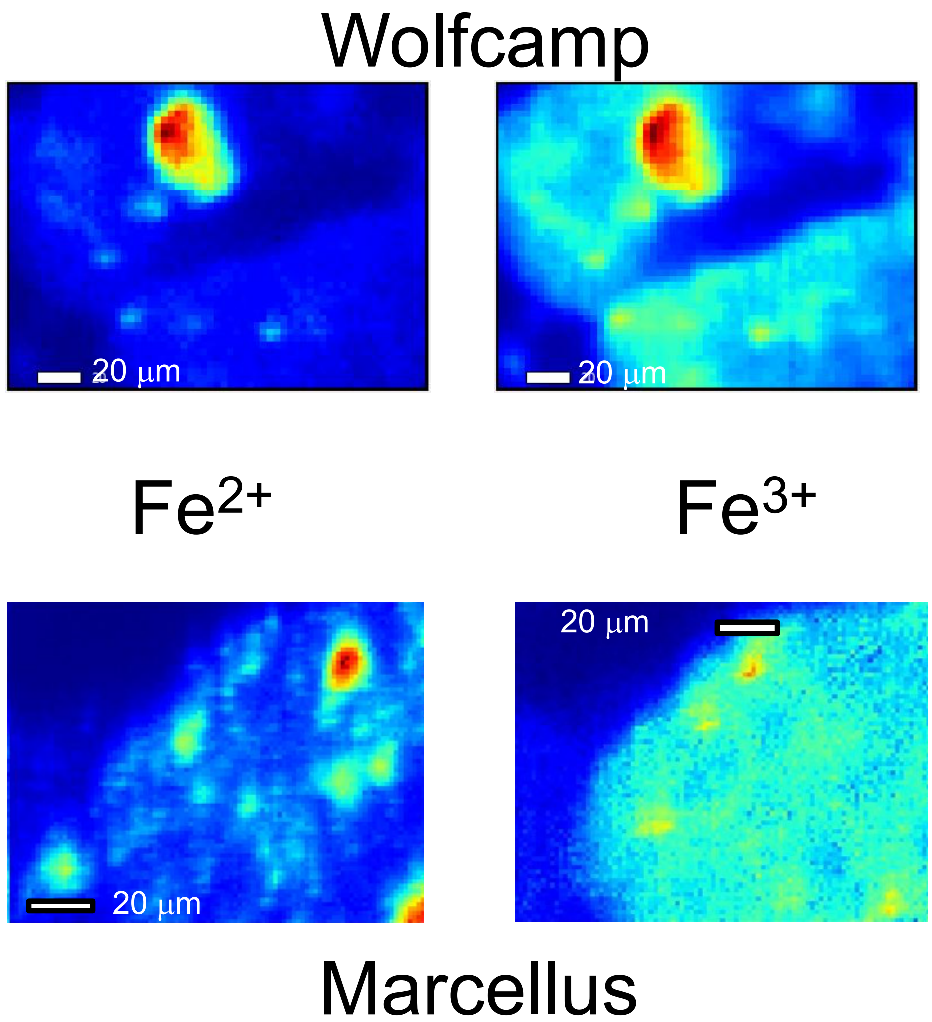
Two ways of Scale Formation: Matrix to surface vs. Solution to Surface

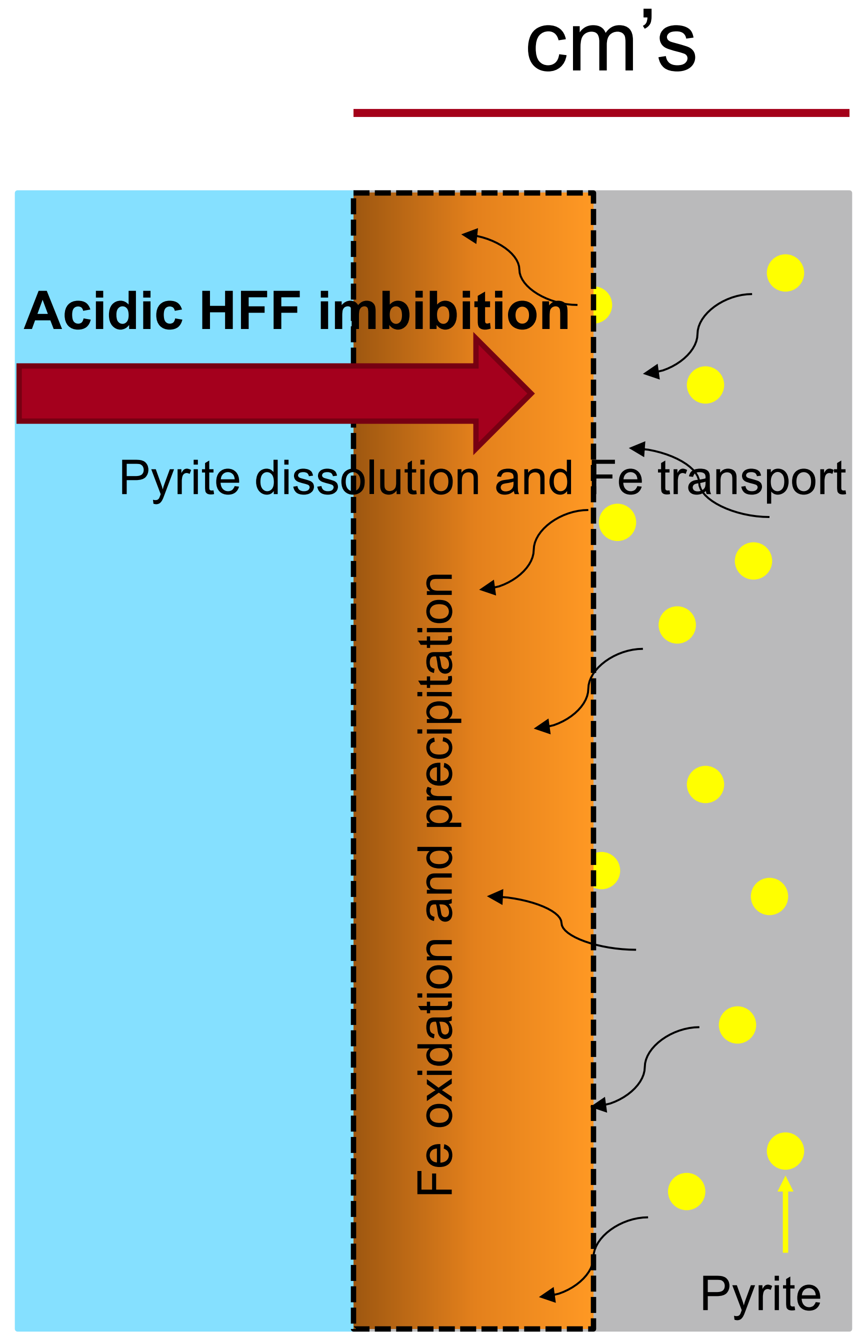


Two ways of Scale Formation: Matrix to surface vs. Solution to Surface



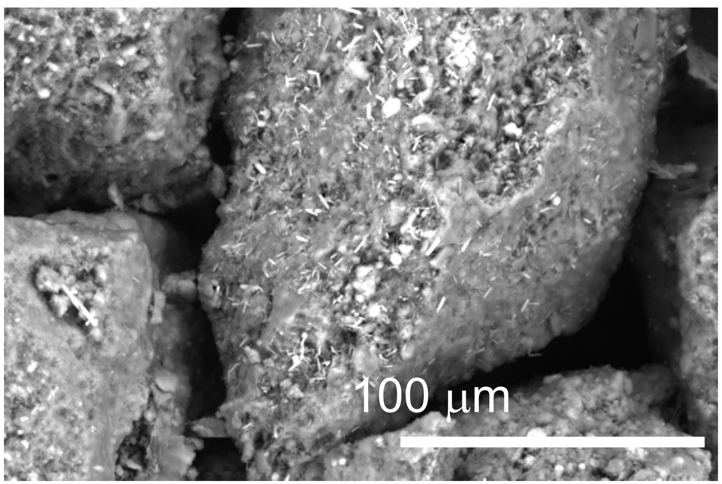
Two ways of Scale Formation: Matrix to surface vs. Solution to Surface

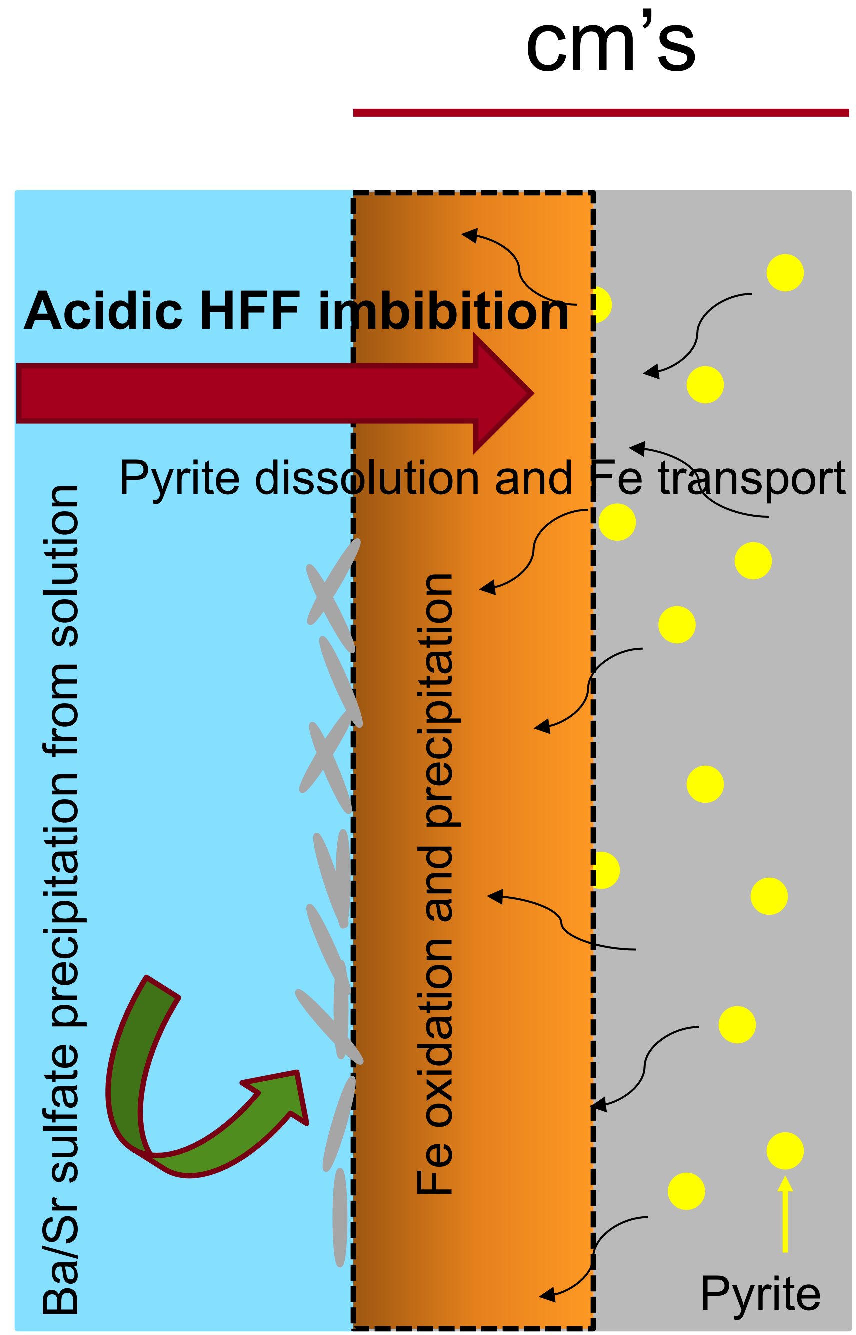




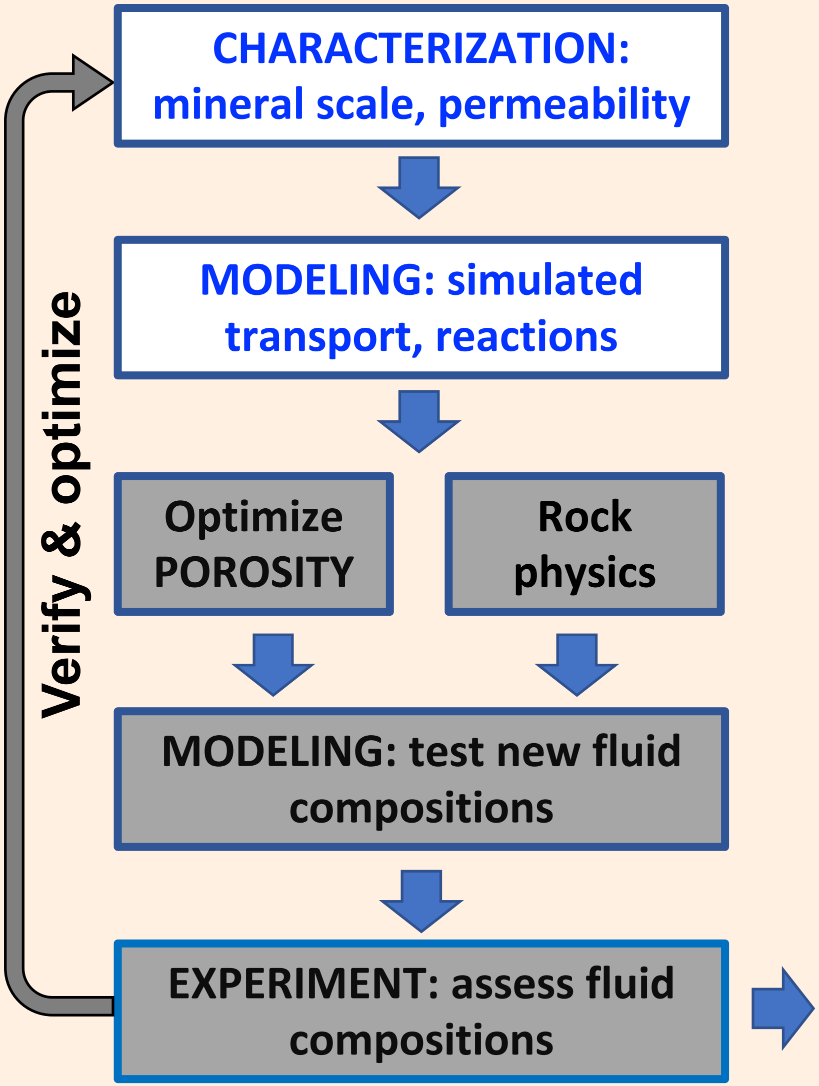
Two ways of Scale Formation: Matrix to surface vs. Solution to Surface

Wolfcamp





Characterization & Simulation

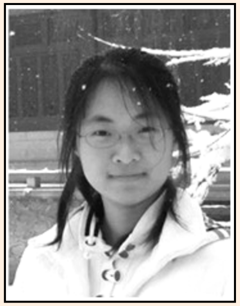


What are the most important forms of mineral scale & What are the controlling reactions?

Druhan

Jew

Li

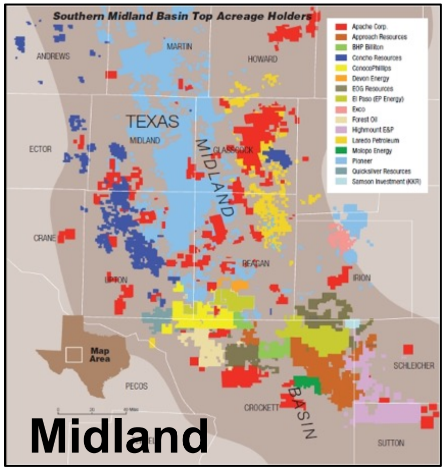


Spielman-Sun

Industry & research community

Sulfate scaling is basin specific

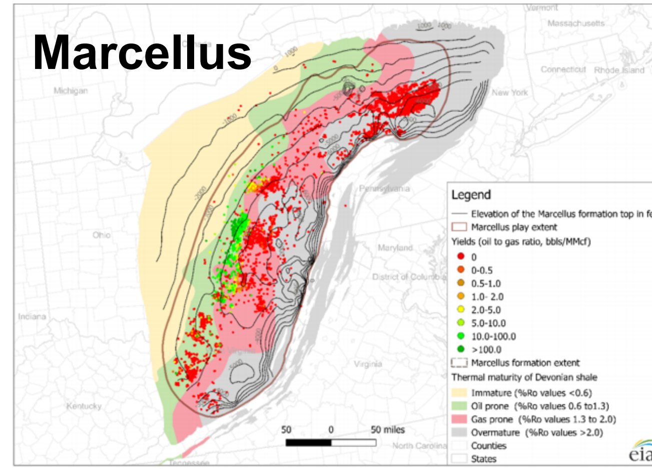
SLAC



Jew *et al.* (2020)

$SrSO_4$ scale generally more important

$BaSO_4$ scale generally more important



Jew *et al.* (2019)

Sr source

- Clean Brine, Fm. water, shale

Ba source

- Drilling mud dissolution
- Drilling mud dissolution, shale

Sulfate source

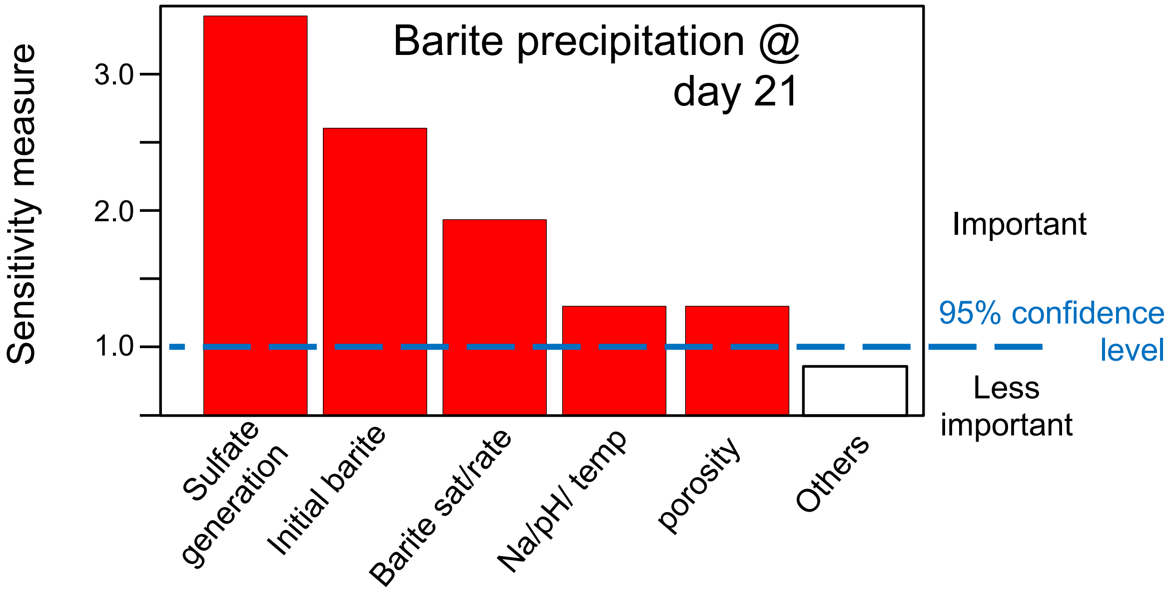
- Breakdown of additives
- Drilling mud dissolution

- Base fluid: SO_4-rich river water
- Drilling mud dissolution

Barite is universal problem; *Degree of problem* is *basin specific*

What factors control barite scale in shale?

- **How to compare wells w/different in fluids, shale mineralogy, well bore conditions?**
- Distance-based Generalized Sensitivity Analysis (DGSA) was adapted to our reactive transport model on shale-HFF interactions
- Controlling factors for barite formation were obtained:



Less important factors (ranked):

- Fluid mass
- Pyrite abundance
- Diffusion coefficient
- Sulfate concentration
- Iron scale in fluid
- …

Li *et al.* (2020) *in review*

Sulfate generation > Initial barite abundance > barite saturation/rates > salinity/pH/temp ~ porosity

Is iron mineral scale equally problematic in all reservoirs?
Bone Spring, Delaware (Permian) Basin

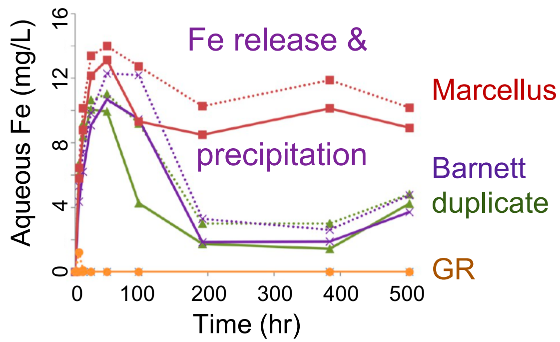
SLAC

Hydraulic fracturing fluid

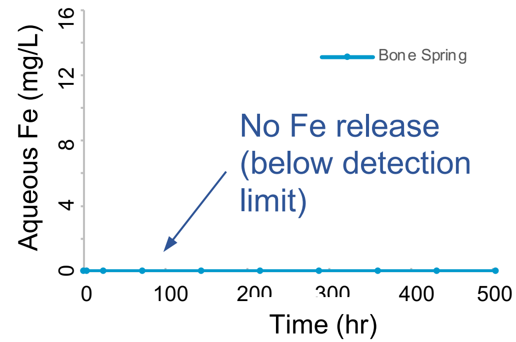
77 bar, 80 °C,
3 weeks

Aqueous chemistry

Marcellus & Barnett
Carbonate poor



Bone Spring
Carbonate Rich



Jew *et al*. *Energy and Fuels* (2017)

Marcellus
Barnett

Eagle Ford

Bone Spring

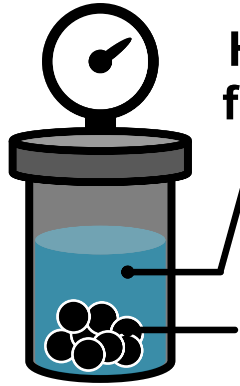
15% Carbonate

50% Carbonate

90% Carbonate

Is iron mineral scale equally problematic in all reservoirs?
Bone Spring, Delaware (Permian) Basin

SLAC



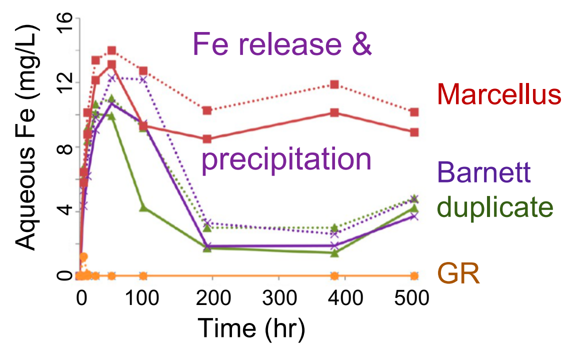
Hydraulic fracturing fluid

Ground shale

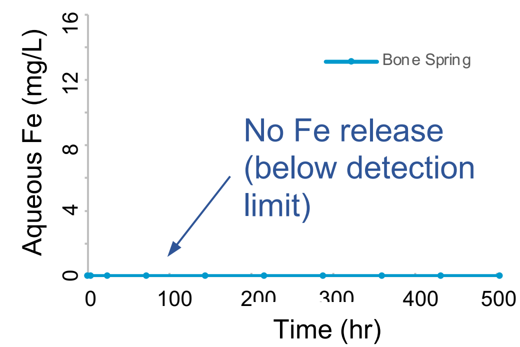
77 bar, 80 °C, 3 weeks

Aqueous chemistry

Marcellus & Barnett
Carbonate poor



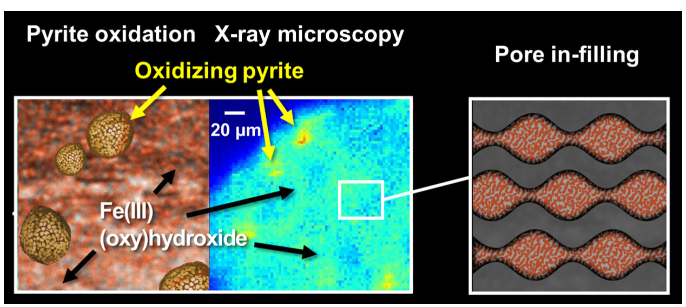
Bone Spring
Carbonate Rich



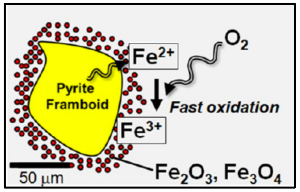
Jew *et al. Energy and Fuels* (2017)

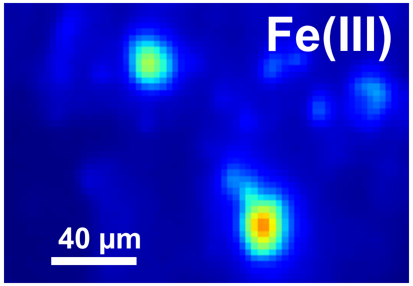
X-ray microprobe chemical mapping: iron scale in reacted shale

Marcellus



Bone Spring



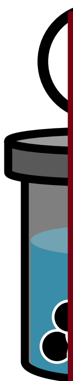


15% Carbonate | 50% Carbonate | 90% Carbonate

Is iron mineral scale equally problematic in all reservoirs? Bone Spring, Delaware (Permian) Basin

SLAC

Aqueous chemistry



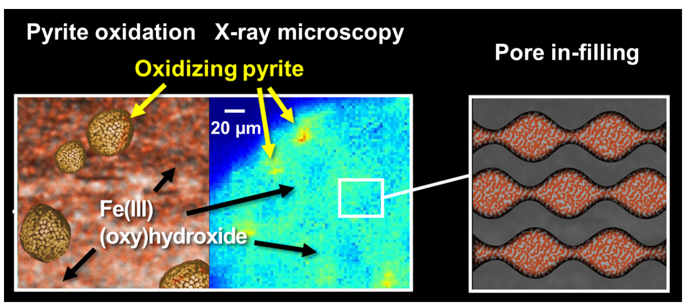
77 b
3

As carbonate concentration increases, fluid pH increases, and Fe(II) → Fe(III) oxidation rate increases

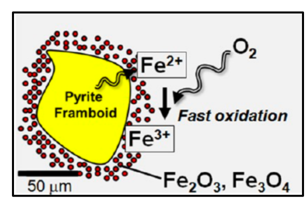
Fe(III) scale accumulates in matrix next to Fe(II) source

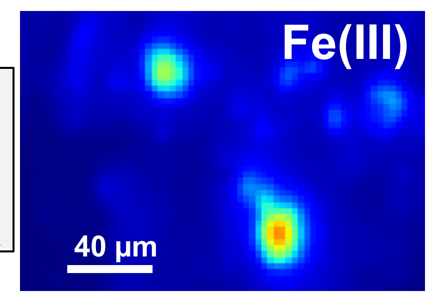
Less clogging of matrix and fractures

Marcellus



Bone Spring





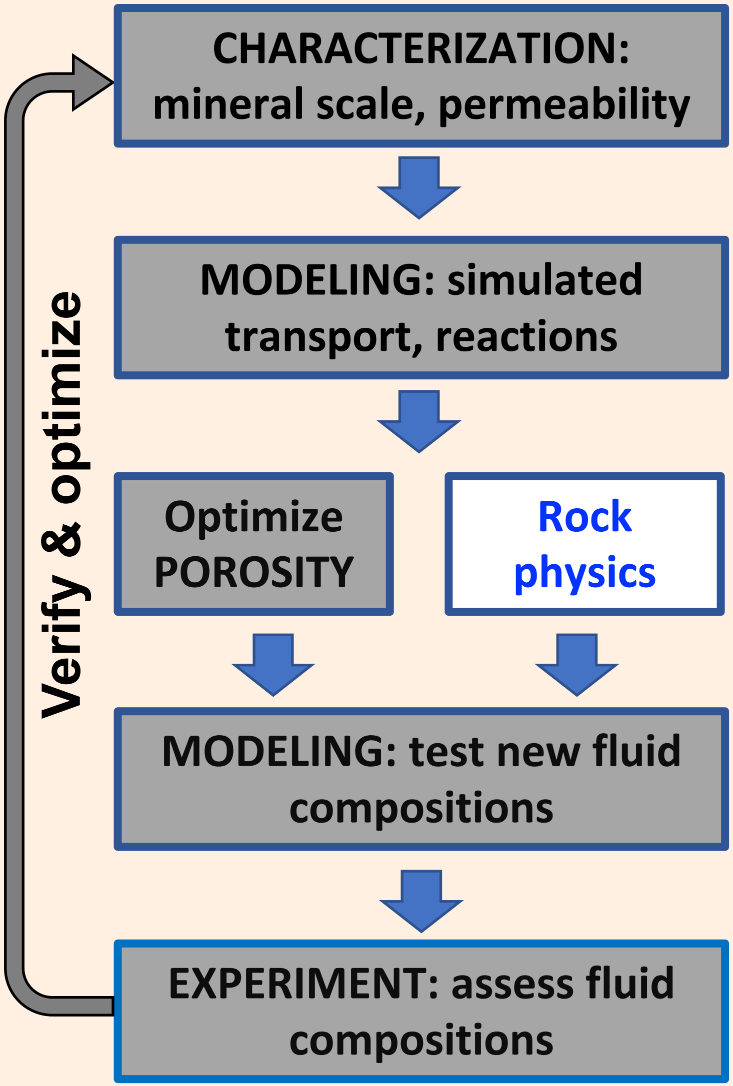
15% Carbonate

50% Carbonate

90% Carbonate

Rock Physics for Monitoring Flow Pathways

SLAC



Can we monitor *effective* flow pathways using seismic?

Vanorio

Ding

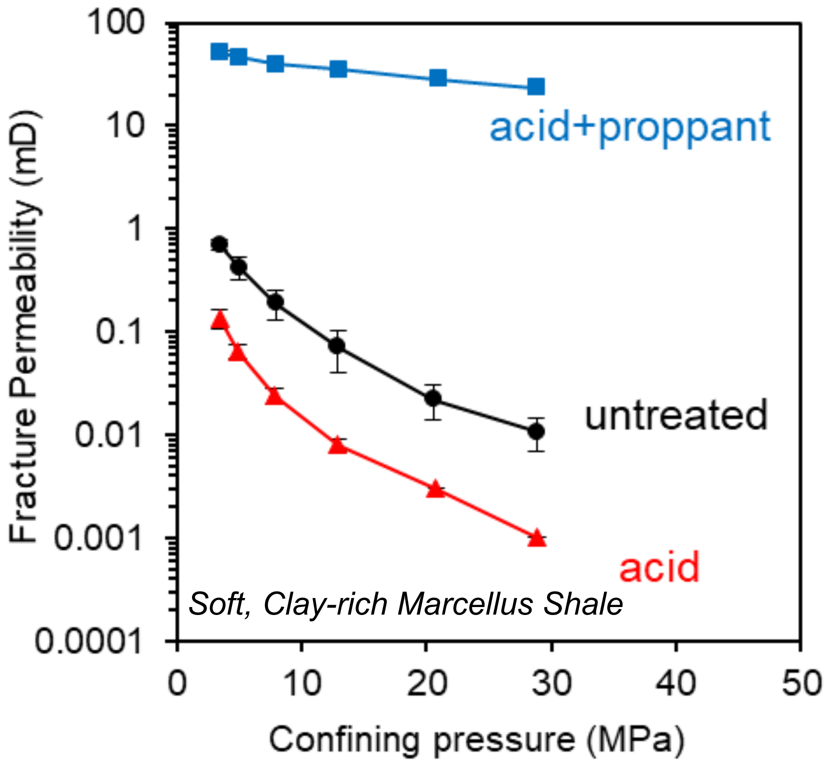
Clark

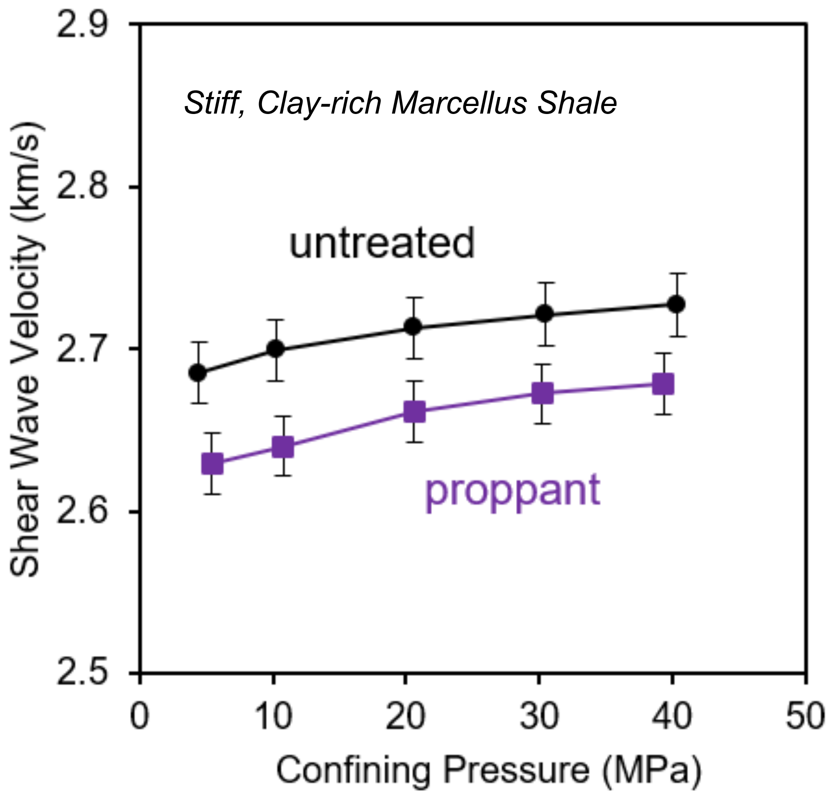
Stanford Geophysics

Industry & research community

Velocity Signatures of Flow Pathways

Soft, clay-rich formation after acidizing: velocity cannot discriminate producing (propped) fractures from non-producing ones!





Stiff, clay-rich formation: producing (propped) fractures can be seismically detected!

Manipulate porosity

SLAC

CHARACTERIZATION: mineral scale, permeability

MODELING: simulated transport, reactions

Optimize POROSITY

Rock physics

MODELING: test new fluid compositions

EXPERIMENT: assess fluid compositions

Verify & optimize

Can we manipulate porosity to improve flow through fracture faces?

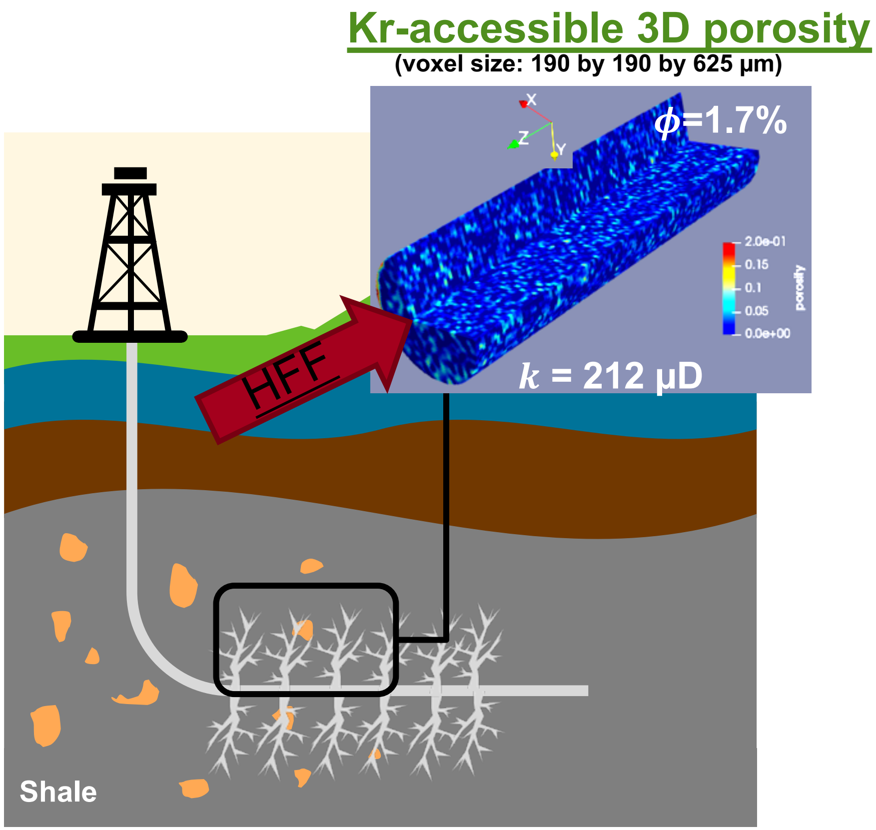
Gundogar

Kovscek

Industry & research community

Establishment of an altered zone

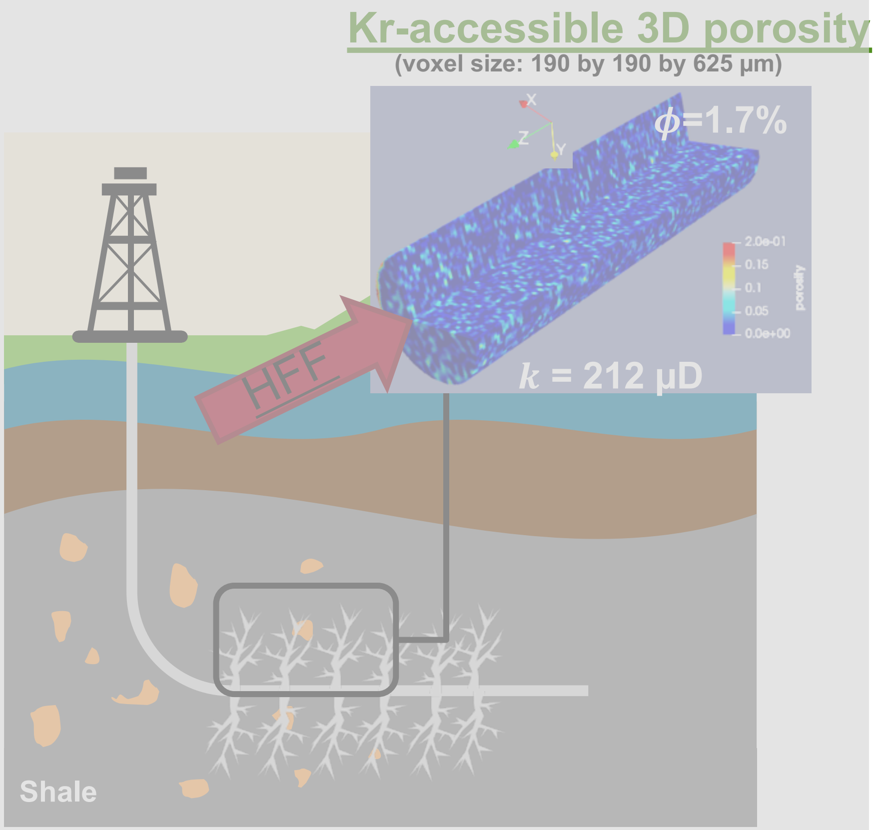
The problem: Injection conditions are far from optimal for stimulating matrix production.

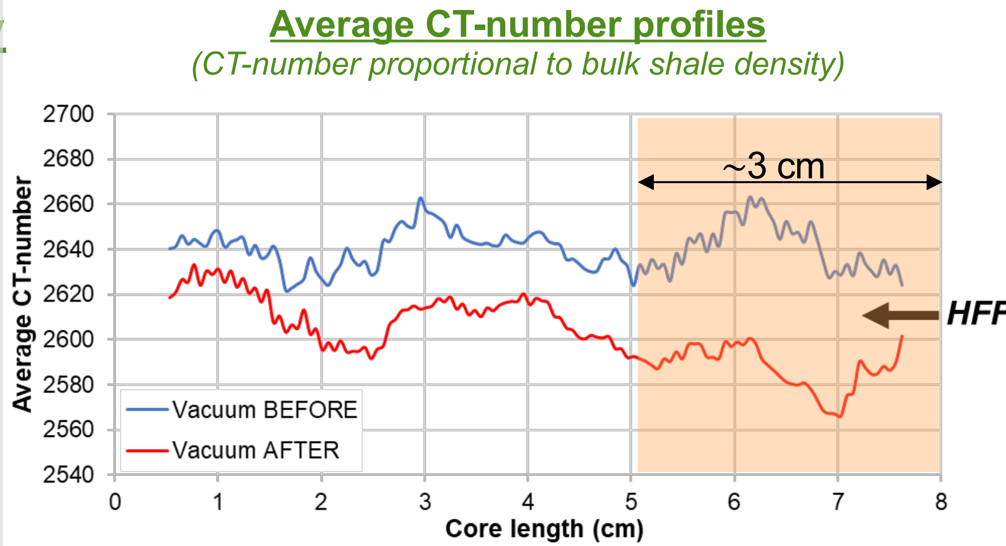


Establishment of an altered zone

The problem: Injection conditions are far from optimal for stimulating matrix production.

The solution: Manipulate chemistry and injection pressure to promote an altered zone.





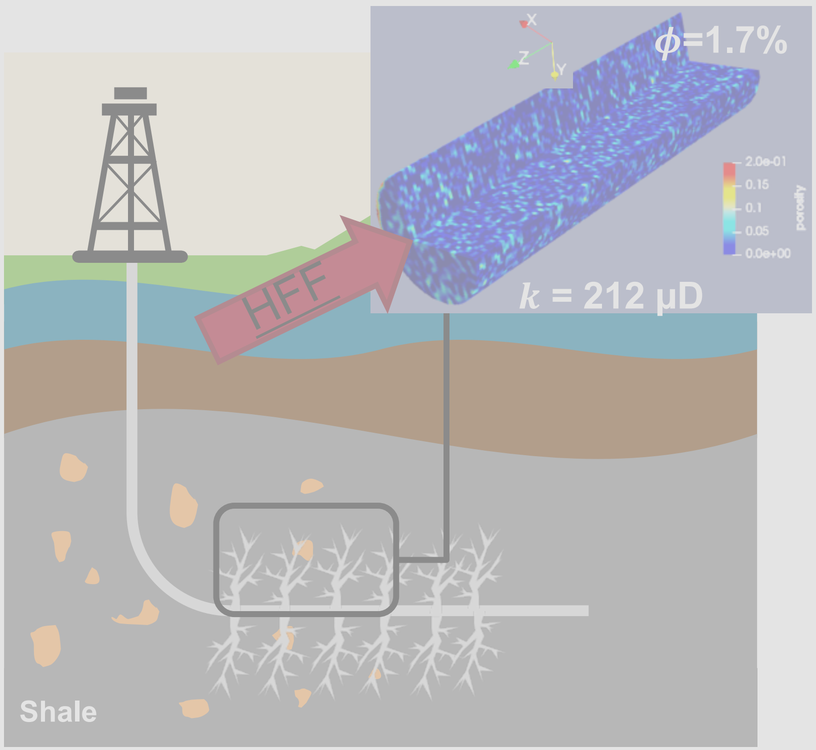
Establishment of an altered zone

The problem: Injection conditions are far from optimal for stimulating matrix production.

The solution: Manipulate chemistry and injection pressure to promote an altered zone.

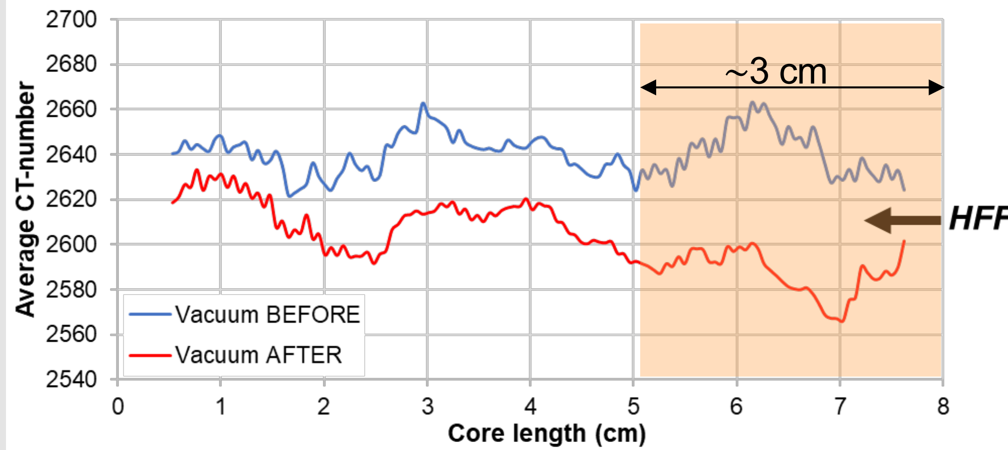
Kr-accessible 3D porosity

(voxel size: 190 by 190 by 625 μm)

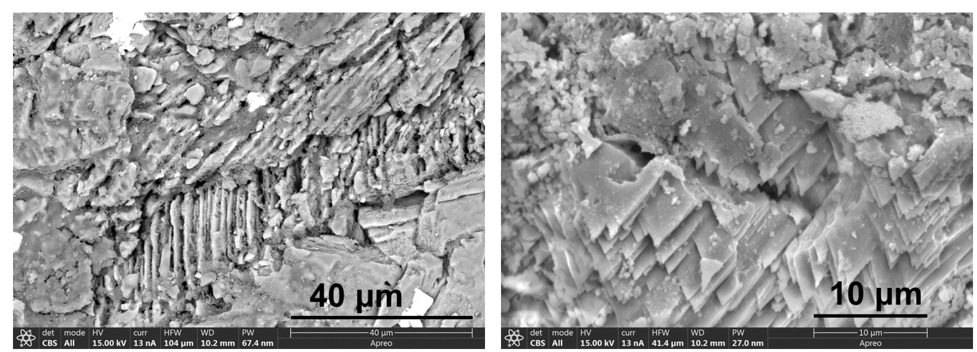


Average CT-number profiles

(CT-number proportional to bulk shale density)



- ***SEM reveals dissolution features of calcite cleavage planes***



Use models to mitigate scale

SLAC

Verify & optimize

CHARACTERIZATION: mineral scale, permeability

↓

MODELING: simulated transport, reactions

↓

Optimize POROSITY | Rock physics

↓

MODELING: test new fluid compositions

↓

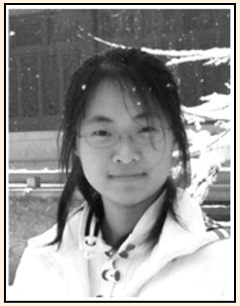
EXPERIMENT: assess fluid compositions → **Industry & research community**

How do we fix mineral scale precipitation?

Druhan

Jew

Li



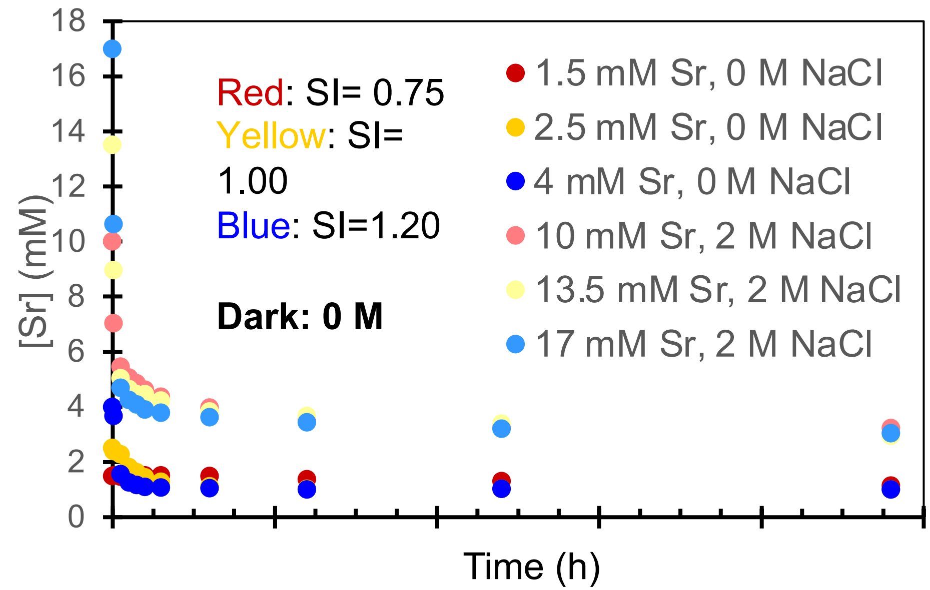
Spielman-Sun

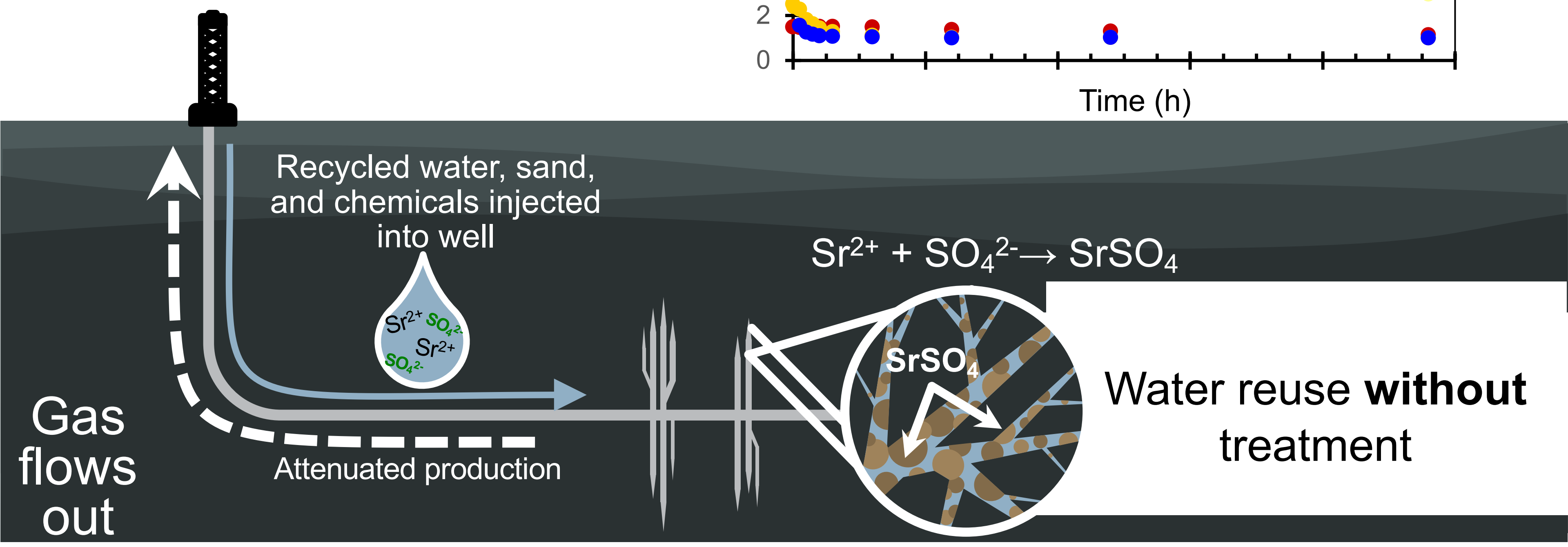
How do we fix scale production: Case study of Celestite

Base fluid water types:

- **Freshwater**: low salinity, low SO_4^{2-}/Sr^{2+}
- **Brackish groundwater**: high salinity, High SO_4^{2-}/low Sr^{2+}
- **Clean brine** (cleaned produced water): highest salinity, low SO_4^{2+}/High Sr^{2+}

➢ **Experimental results**





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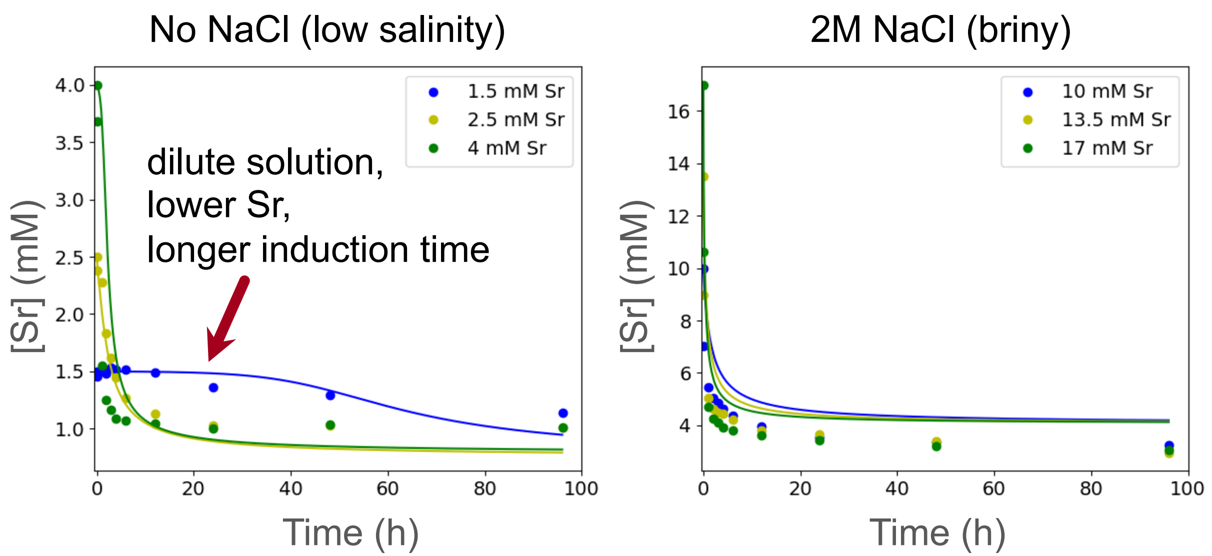
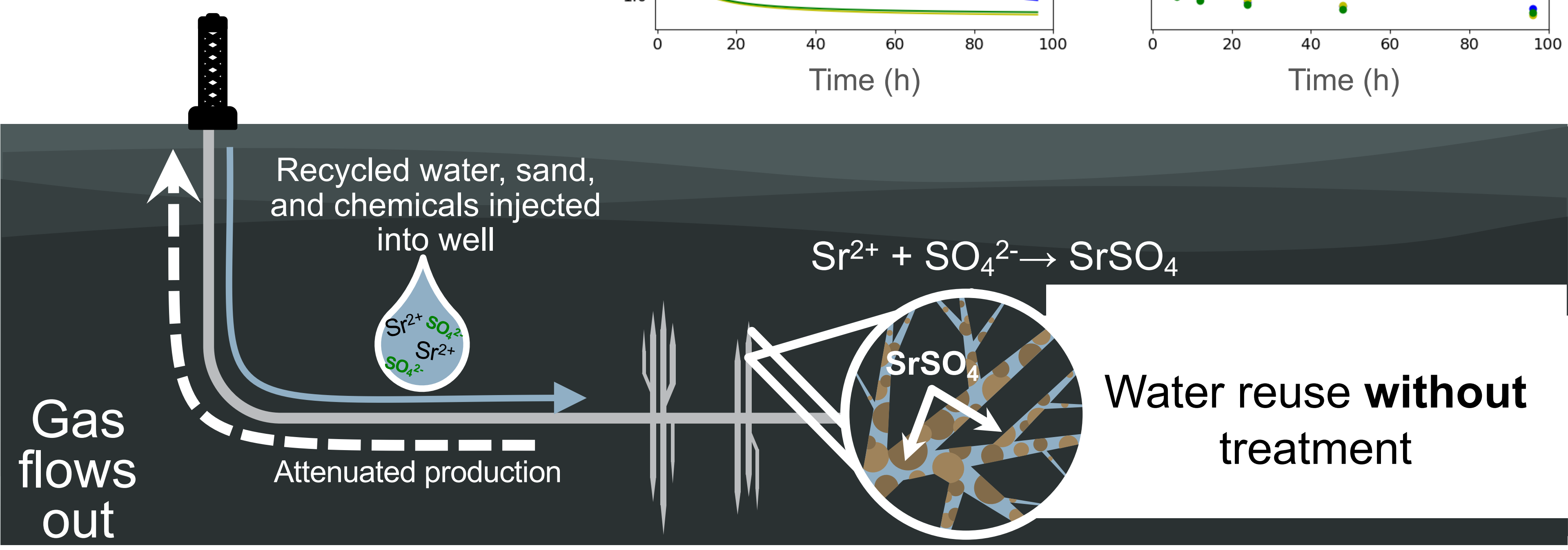
➢ **Model results**

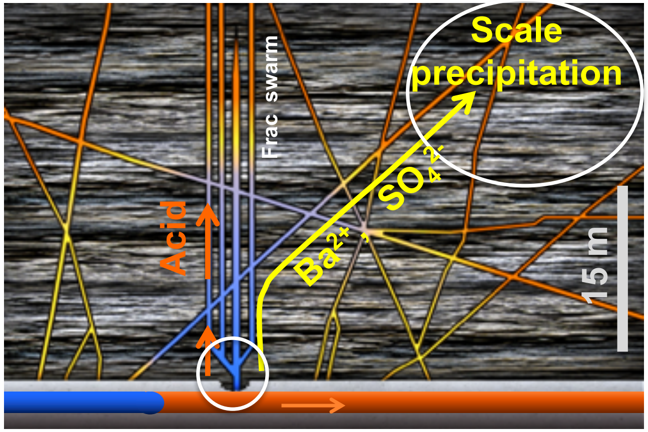


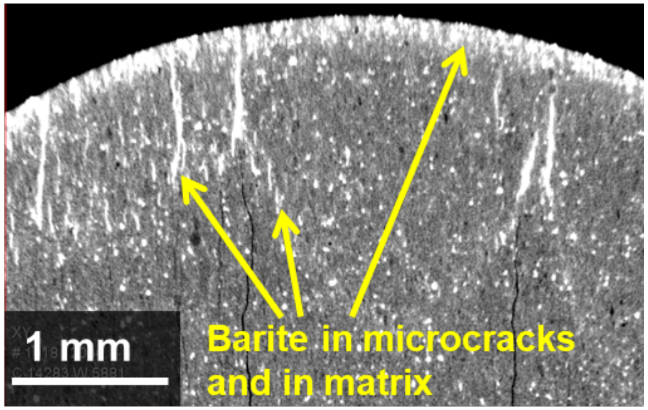


Accomplishments

Accomplishments:

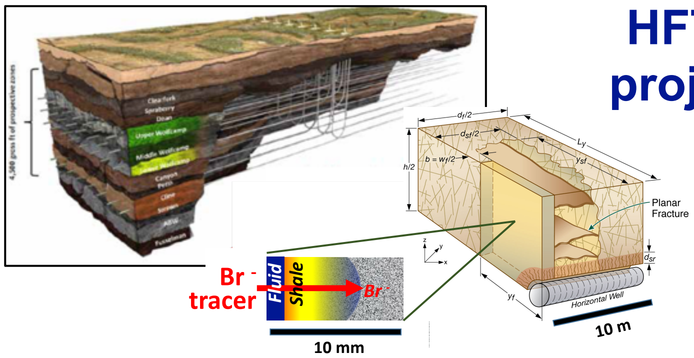
- ✓ Published 16 manuscripts; 1 in review; 3 in preparation: Fe, Ba, and Sr scale formation mechanisms
- ✓ Developed & patented acid-swap mitigation for Ba scale
- ✓ Providing water treatment targets for Sr scale mitigation
- ✓ Working with 3 industrial partners to use new scale mitigation knowledge in industrial practices
- ✓ Discovered/quantified organic-mediated Fe oxidation and scale precipitation mechanisms
- ✓ Introduced new technologies for unconventional geochemistry monitoring



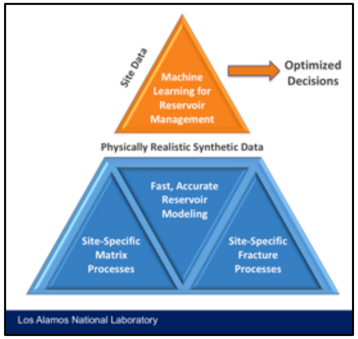


Synergies & Opportunities

National Laboratory Partners



HFTS project



Unconventional Reservoir Management

Industrial Partners

THANK YOU!

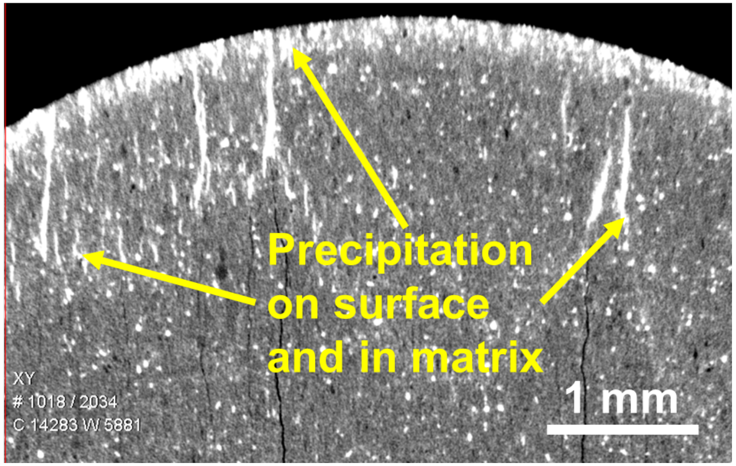
Appendices

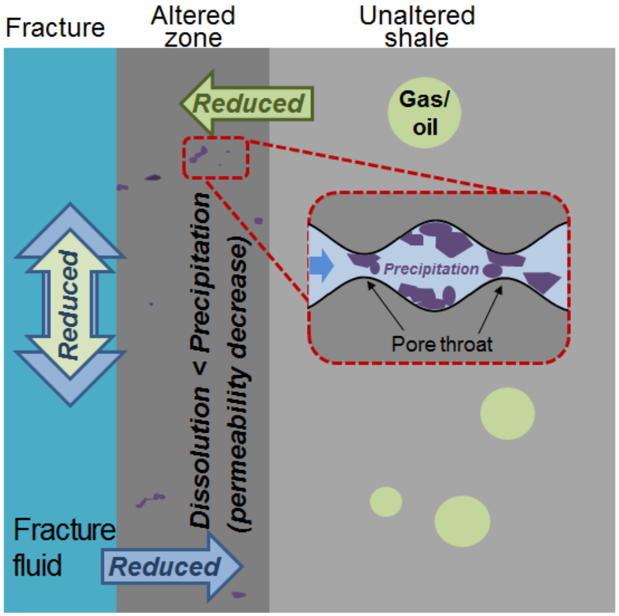
Benefit to the Program

Program goals addressed:

- Improve ***recovery factors***
- Improve ***water reuse/recycling***
- Provide new knowledge for geochemical control of subsurface mineral scale and porosity

Fracture-fluid interfaces are crucial





Lessons learned

- Modeling is crucial to testing process models and finding weaknesses in understanding of shale geochemistry
- Comparing shale-fluid reactivity across basins, compositions is critical to developing geochemical and geomechanical insights
- Laboratory-based surface imaging techniques (SEM) can not be used to study reactions/precipitation occurring in shale matrix

Project Summary

https://netl.doe.gov/node/6301:

This project is focusing on two strategic geochemistry-based research thrusts where new knowledge can immediately begin to improve unconventional gas and oil recovery factors. First, we are evaluating mineral scale precipitation processes specific to major shale formations and fracture stimulation practices and developing geochemistry-based approaches to mitigate it. This knowledge has an additional benefit of improving our ability to reuse flowback and produced water without causing formation damage. The focus of this work will be to compare and contrast conditions specific to Marcellus (dry gas) and Midland (oil) basins. We are also conducting research to understand how geochemistry can be used to manipulate the thickness and permeability of the altered zone by focusing on controlling microscale chemical and mechanical features such as secondary porosity created during stimulation, the connectivity of this porosity across the altered zone, and irreversible mineral scale precipitation within the altered zone. Our ultimate goal is to develop approaches to manipulate the thickness and permeability of the altered zone during stimulation to increase access to matrix and thus production recovery factors.

To monitor scale precipitation and microstructure evolution within shales, we are using a combination of laboratory, synchrotron X-ray imaging, computed tomography, electron microscopy, and seismic techniques. Research is being performed in consultation with industrial experts to help facilitate technology transfer from the laboratory to the field.

Project overview

Project goals: Develop new knowledge about critical mineral scale and porosity generating processes. Use this information enable transformation industrial processes to IMPROVE EFFICIENCY and WATER REUSE

(i) Identify chemical parameters that control scale in different basins.

(ii) Develop chemical strategies to mitigate scale.

(iii) Develop next-generation geochemistry tools to monitor & mitigate subsurface mineral scale precipitation and optimize porosity *in real time in the field*

(iv) Systematically manipulate altered zone porosity to improve permeability

Success criteria:

- On-time execution of PMP
- Presentations at industrial and scientific meetings
- Publications in major journals, including URTeC proceedings
- Interaction with industry
- Patent filings

Organization Chart, Expertise, and Roles

SLAC director
Chi-Chang Kao

SSRL director
Paul McIntyre

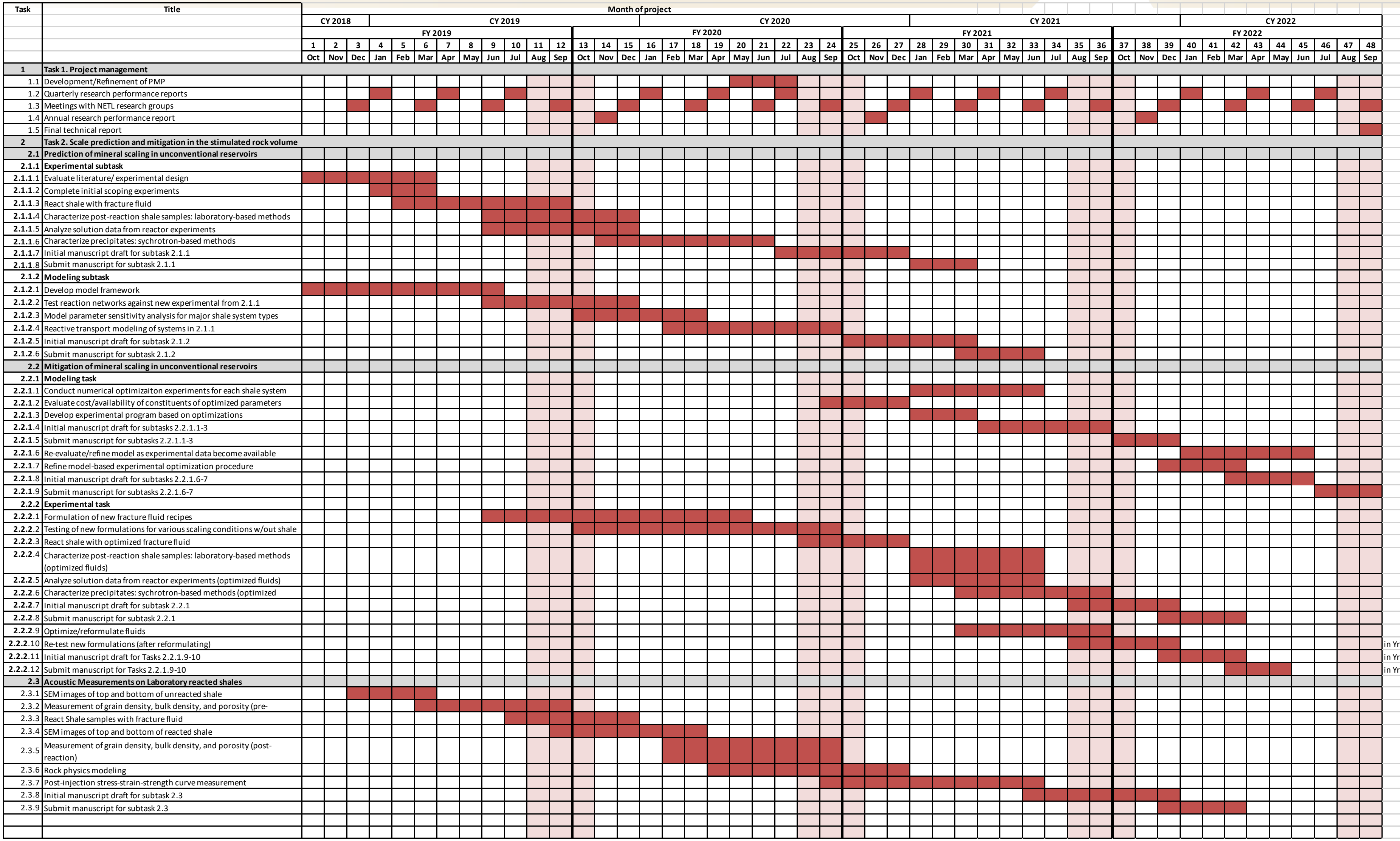
SSRL science director
Britt Hedman

Senior Scientist, Research Manager
John Bargar

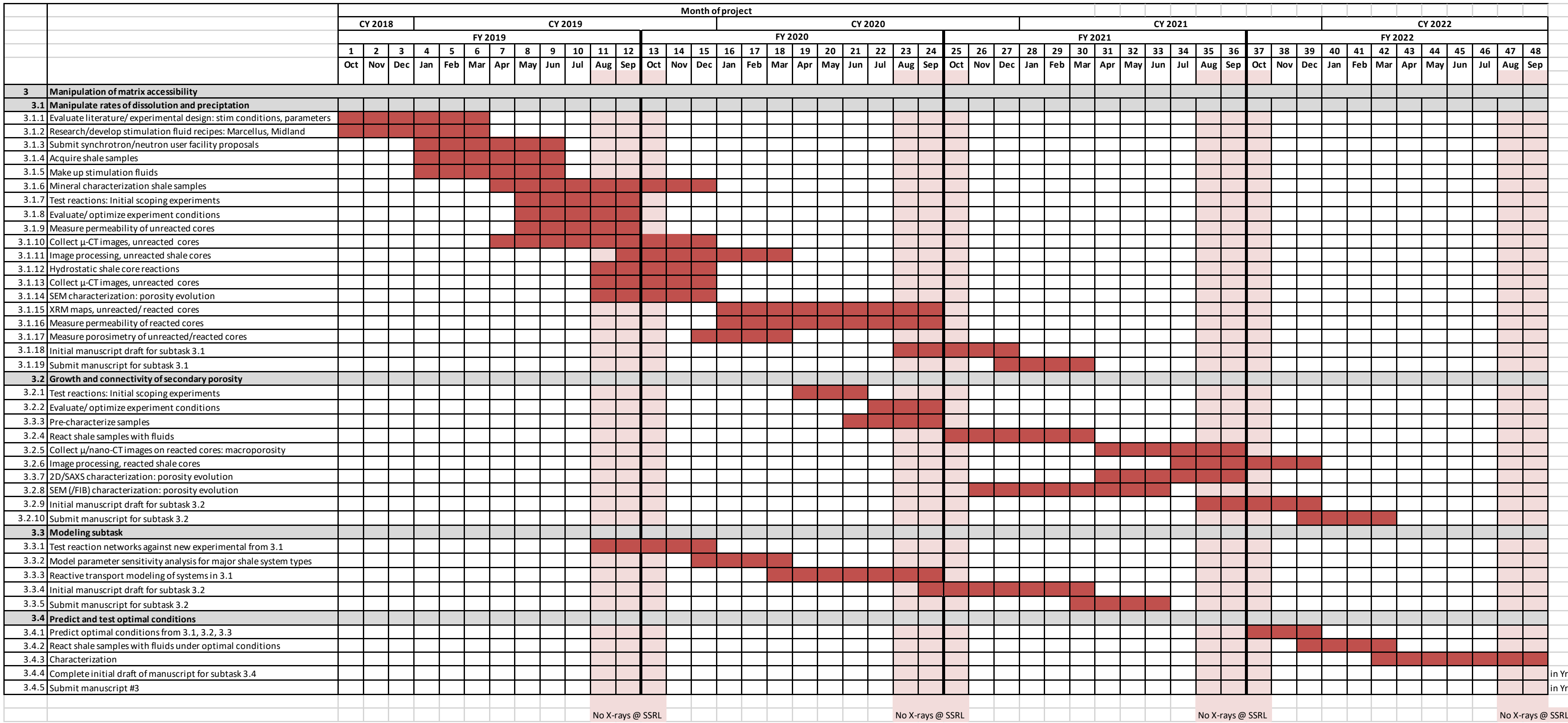
Background: Geochemistry synchrotron-based spectroscopy, imaging

	Task lead	**Postdoctoral scholar**
Task 1.0:	John Bargar	Program management
Task 2.1:	Adam Jew *Geochemistry*	Eleanor Spielman-Sun
Task 2.2:	Jennifer Druhan *Reactive transport*	Qingyun Li
Task 2.3:	Tiziana Vanorio *Rock physics*	Jihui Ding
Task 3.0:	Tony Kovscek: *Fluid flow, reservoir engineering*	Asli Gundogar

Gantt Chart: Tasks 1-2



Gantt Chart: Task 3



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Publications

Patents

1. Patent (2019) - Fracture fluid alteration to mitigate barite scale precipitation in unconventional oil/gas shale systems. Patent ID: 62/717326

Manuscripts published, submitted, or in revision

2. Jew, A. D.; Bargar, J. R.; Brownlow, J., Strontium behavior in midland basin unconventional reservoirs: the importance of base fluids. *Extended abstract of the Unconventional Resources Technology Conference: Jul 20-22, Austin, TX*, **2020**. DOI: 10.15530/urtec-2020-3016
3. Jew, A. D.; Besancon, C. J.; Roycroft, S. J.; Noel, V. S.; Brown, G. E. Jr.; Bargar, J. R., Chemical speciation and stability of uranium in unconventional shales: impact of hydraulic fracture fluid. *Environmental Science and Technology*. **2020,** 54 (12) 7025-7734. DOI: 10.1021/acs.est.0c01022
4. Li, Q.; Jew, A. D.; Brown, G. E. Jr.; Bargar, J. R.; Maher, K., Reactive transport modeling of shale-fluid interactions after imbibition of fracturing fluids. *Energy and Fuels*, 34 (5), 5511-5523, **2020**. DOI: 10.1021/acs.energyfuels.9b04542
5. Ding, J.; Clark, A. C.; Vanorio, T.; Jew, A. D.; Bargar, J. R., Acoustic velocity signatures of acidized and propped fractures in Marcellus shale. *SEG Technical Program Expanded Abstracts* ***2020**,* pp 2434-2438. DOI: 10.1190/segam2020-3427203.1
6. Gundogar, A. S.; Ross, C. M.; Li, Q.; Jew, A. D.; Bargar, J. R.; Kovscek, A. R., Multiscale imaging of core flooding experiments during transport of reactive fluids in fractured unconventional shales. *Extended abstract for the 2020 SPE Western Regional Meeting*, *Bakersfield, CA, April 27–30*. Accepted and decided to postpone to a later date, **2020**.

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7. Jew, A. D.; Li, Q.; Cercone, D.; Brown, G.E. Jr.; Bargar, J. R., A new approach to controlling barite scaling in unconventional systems. URTEC-512-MS. *Extended Abstracts of the Unconventional Resources Technology Conference*: *Denver, Colorado, USA* **2019**. DOI 10.15530/urtec-2019-512.
8. Li, Q.; Jew, A. D.; Kohli, A.; Maher, K.; Brown, G. E. Jr.; Bargar, J. R., Thicknesses of chemically altered zones in shale matrices resulting from Interactions with hydraulic fracturing fluid. *Energy & Fuels* **2019**, 33 (8), 6878-6889. DOI: 10.1021/acs.energyfuels.8b04527
9. Li, Q.; Jew, A.; Cercone, D.; Bargar, J.; Brown, G. E. Jr.; Maher, K., Geochemical modeling of iron (hydr)oxide scale formation during hydraulic fracturing operations. *Extended Abstracts of the Unconventional Resources Technology Conference: Denver, Colorado, USA* **2019**, p 14. DOI: 10.15530/urtec-2019-612.
10. Jew, A. D.; Li, Q.; Cercone, D.; Maher, K.; Brown, G. E. Jr.; Bargar, J. R., Barium sources in hydraulic fracturing systems and chemical controls on its release Into solution. *Extended Abstracts of the Unconventional Resources Technology Conference: Houston, Texas, USA* **2018**, p 12. DOI: 10.15530/URTEC-2018-2899671.
11. Li, Q.; Jew, A. D.; Kiss, A. M.; Kohli, A.; Alalli, A.; Kovscek, A. R.; Zoback, M. D.; Cercone, D.; Maher, K.; Brown, G. E., Jr.; Bargar, J. R., Imaging pyrite oxidation and barite precipitation in gas and oil shales. *Extended Abstracts of the Unconventional Resources Technology Conference: Houston, Texas, USA* **2018**, p 10. DOI: 10.15530/URTEC-2018-2902747.
12. Alalli, A.; Li, Q.; Jew, A.; Kohli, A.; Bargar, J.; Zoback, M.; Kovscek, A., Effects of hydraulic fracturing fluid chemistry on shale matrix permeability. *Extended Abstracts of the Unconventional Resources Technology Conference: Houston, Texas, USA* **2018**, p 10. DOI: 10.15530/URTEC-2018-2881314.
13. Dustin, M. K.; Bargar, J. R.; Jew, A. D.; Harrison, A. L.; Joe-Wong, C.; Thomas, D. L.; Brown, G. E.Jr.; Maher, K., Shale kerogen: hydraulic fracturing fluid interactions and contaminant release. *Energy & Fuels* **2018**, 32 (9), 8966-8977. DOI: 10.1021/acs.energyfuels.8b01037.
14. Jew, A. D.; Harrison, A. L.; Kiss, A. M.; Dustin, M. K.; Joe-Wong, C.; Thomas, D. L.; Maher, K.; Brown, G. E. Jr.; Cercone, D.; Bargar, J. R., Mineralogical and physical changes that control pore-scale shale-gas properties. *Extended Abstracts of the Unconventional Resources Technology Conference: Austin, Texas, USA* **2017**, p 7. DOI: 10.15530/urtec-2017-2708858

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15. Jew, A. D.; Dustin, M. K.; Harrison, A. L.; Joe-Wong, C. M.; Thomas, D. L.; Maher, K.; Brown, G. E. Jr.; Bargar, J. R., Impact of organics and carbonates on the oxidation and precipitation of iron during hydraulic fracturing of shale. *Energy & Fuels* **2017**, 31 (4), 3643-3658. DOI: 10.1021/acs.energyfuels.6b03220
16. Harrison, A.; Jew, A.; Dustin, M.; Thomas, D.; Joe-Wong, C.; Bargar, J. R.; Johnson, N.; Brown, G. E. Jr.; Maher, K., Element release and reaction-induced porosity alteration during shale-hydraulic fracturing fluid interactions. *Applied Geochemistry* **2017**, 82. DOI: 10.1016/j.apgeochem.2017.05.001
17. Kiss, A.; Jew, A.; Joe-Wong, C.; Maher, K.; Liu, Y.; Brown, G.; Bargar, J., Synchrotron-based transmission x-ray microscopy for improved extraction in shale during hydraulic fracturing. *SPIE: Optical Engineering + Applications*, **2015**; Vol. 9592. DOI: doi:10.1117/12.2190806

Invited Presentations at National Meetings and Departmental Seminars

18. Jew, A.D. (2020) Field laboratories: a data driven approach for basin specific research. Presented at the Unconventional Resources Technology Conference. Austin, TX. Jul 20-22. [Invited]
19. Druhan, J. L.; Ling, B.; Davila, G.; Battiato, I. (2019) Imaging the reactive transport properties of sedimentary formations across scales. Presented at the AGU Fall Meeting. Dec 9-13, San Francisco, CA. [Invited]
20. Noël, V.; Fan, W.; Druhan, J.; Jew, A. D.; Li, Q.; Kovscek, A.; Brown, G. E. Jr.; Bargar, J. R. (2019) X-ray imaging of tracer reactive transport in unconventional shales. Presented at the CMC-UF all hands meeting, Stanford University. Oct 24. Palo Alto, CA. [Invited]
21. Jew, A. D.; Li, Q.; Cercone, D.; Brown, G. E. Jr.; Bargar, J. R. (2019) A New approach to controlling barium scaling in unconventional systems. Presented at the Unconventional Resources Technology Conference (URTeC). Apr. 22. Pittsburgh, PA. [Invited]
22. Bargar, J. R.; Jew, A. D.; Harrison, A. L.; Kiss, A.; Kohli, A.; Li, Q.; Maher, K.; Brown, G. E. Jr. (2017) Geochemistry of shale-fluid reactions at pore and fracture scales. Presented at the Goldschmidt Geochemistry conference. Aug 16. [Invited]

Presentations

23. Bargar, J. R.; Kiss, A.; Kohli, A.; Harrison, A. L.; Jew, A. D.; Dustin, M.; Joe-Wong, C.; Maher, K.; Brown, G. E. Jr.; Zoback, M.; Liu, Y.; Cercone, D. (2016) Geochemistry of shale-fluid reactions at pore and fracture scales. Presented at the 252nd American Chemical Society National Meeting. Aug 21. [Invited]
24. Bargar, J. R.; Brown, G. E. Jr.; Dustin, M. K.; Harrison, A. L.; Jew, A. D.; Joe-Wong, C.M.; Maher, K. (2015) Geochemical control of shale fracture and matrix permeability. Presented at the Shales without Scales Workshop. Santa Fe, USA. June 10. [Invited]
25. Bargar, J. R.; Brown, G. E. Jr.; Dustin, M. K.; Harrison, A. L.; Jew, A. D.; Joe-Wong, C.M.; Maher, K. (2015) Geochemical control of shale fracture and matrix permeability. Presented at Baker Hughes Incorporated, Tomball, USA, July 14. [Invited]

Talks and Posters Presented at National Meetings.

26. Ding, J.; Clark, A. C.; Vanorio, T.; Jew, A. D.; Bargar, J. R. (2020) Time-lapse acoustic monitoring of fracture alteration in Marcellus shale. Presented at the Unconventional Resources Technology Conference. Austin, TX. Jul 20-22. [Oral]
27. Jew, A.D.; Bargar, J.R.; Brownlow, J.; Laughland, M. (2020) Strontium behavior in Midland Basin unconventional reservoirs: the importance of base fluids. . Presented at the Unconventional Resources Technology Conference. Austin, TX. Jul 20-22. [Oral]
28. Gundogar, A.S.; Ross, C.M.; Jew, A.D.; Bargar, J.R.; Kovscek, A.R. (2020) Multiscale Imaging of Reactive Fluid Transport in Fractured Shales. Presented at the SUPRI-A Annual Affiliates Meeting. Stanford, CA. June 11 [Oral].
29. Gundogar, A.S.; Ross, C.M.; Li, Q.; Jew, A.D.; Bargar, J.R.; Kovscek, A.R. (2019) Multiscale imaging characterization of fracture fluid migration and reactive transport in shales. Presented at the AGU Fall Meeting. San Francisco, CA. Dec 9-13. [Poster]

Presentations

30. Noël, V.; Fan, W.; Bargar, J.R.; Druhan, J.; Jew, A.D.; Li, Q.; Brown, G.E. Jr. (2019) Synchrotron x-ray imaging of reactive transport in unconventional shales. Presented at AGU Fall Meeting, symposium H44B: porous media across scales: from interfacial properties to subsurface processes. San Francisco, CA. Dec 12. [Oral]
31. Li, Q.; Jew, A. D.; Brown G. E. Jr.; Bargar, J. R.; Maher, K. (2019) Reactive transport in shale matrix after fracturing fluid imbibition. Presented at the American Institute of Chemical Engineers (AIChE) Annual Meeting, Orlando, FL. November 10-15. [Oral]
32. Noël, V.; Fan, W.; Bargar, J.R.; Druhan, J.; Jew, A.D.; Li, Q.; Kovscek, A.R; Brown, G. E. Jr. (2019) Synchrotron x-ray imaging of reactive transport in unconventional shales. Presented at the SSRL annual users meeting, Menlo Park, CA. Sept 25. [Poster]
33. Jew, A. D.; Harrison, A.; Li, Q.; Cercone, D. P.; Maher, K.; Bargar, J. R.; Brown, G. E. Jr. (2019) Unconventional mineralogy: interactions of hydraulic fracturing fluids with minerals and organic matter in unconventional and tight oil formations. Presented at the Geological Society of America Annual Meeting. Phoenix, AZ. September 23. [Talk]
34. Li, Q.; Jew, A. D.; Bargar, J. R.; Lopano, C. L.; Hakala, A. J.; Stuckman, M. Y. (2019) Shale-gas-fluid interaction for water and energy. Presented at the ACS National Meeting & Exposition. Orlando, FL. March 31. [Talk]
35. Jew, A. (2018) Pore Scale Control of Gas and Fluid Transport at Shale Matrix-Fracture Interfaces. Presented research at Mastering the subsurface through technology innovation partnerships and collaboration: carbon storage and oil and natural gas technologies review meeting, Pittsburgh, PA, Aug. 13-16, 2018. [Talk]
36. Hakala, A.; Morris, J.; Bargar, J. R.; Birkholzer, J. (2018) Fundamental shale interactions-DOE National Laboratory Research. Presented at the DOE Upstream Workshop. Houston, TX. Feb. 14. [Talk]
37. Jew, A. D.; Cercone, D.; Li, Q.; Dustin, M. K.; Harrison, A. L.; Joe-Wong, C.; Thomas, D. L.; Maher, K.; Brown, G. E. Jr.; Bargar, J. R. (2017) Chemical controls on secondary mineral precipitation of Fe and Ba in hydraulic fracturing systems. Presented at the American Institute of Chemical Engineers (AIChE) Annual Meeting, Minneapolis, MN. Oct. 29-Nov. 3. [Talk]
38. Li, Q.; Jew, A. D.; Brown, G. E. Jr.; Bargar, J. R. (2017) Chemical reactivity of shale matrixes and the effects of barite scale formation. Presented at the AGU Fall Meeting. New Orleans, LA. Dec. 11-15. [Talk]

Presentations

39. Jew, A. D.; Dustin, M. K.; Harrison, A. L.; Joe-Wong, C.; Thomas, D. L.; Maher, K.; Brown G. E. Jr.; Bargar J. R. (2016) The Importance of pH, oxygen, and bitumen on the oxidation and precipitation of Fe(III)-(oxy)hydroxides during hydraulic fracturing of oil/gas shales. Presented at the American Geophysical Union Fall Meeting. San Francisco, USA. December 13. [Talk]
40. Bargar, J. R.; Kiss, A.; Kohli, A.; Harrison, A. L.; Jew, A. D.; Lim, J.-H.; Liu, Y.; Maher, K.; Zoback, M.; Brown, G. E. Jr. (2016) Synchrotron X-ray imaging to understand porosity development in shales during exposure to hydraulic fracturing fluid. Presented at the American Geophysical Union Fall Meeting. San Francisco, USA. December 12. [Talk]
41. Harrison, A. L.; Maher, K.; Jew, A. D.; Dustin, M. K.; Kiss, A.; Kohli, A.; Thomas, D. L.; Joe-Wong, C.; Brown G. E. Jr.; Bargar, J. R. (2016) The impact of mineralogy on the geochemical alteration of shales during hydraulic fracturing operations. Presented at the American Geophysical Union Fall Meeting. San Francisco, USA. December 13. [Talk]
42. Harrison, A.; Maher, K.; Jew, A.; Dustin, M.; Kiss, A.; Kohli, A.; Thomas, D.; Joe-Wong, C.; Liu, Y.; Lim, J.-H.; Brown, G. E. Jr.; Bargar, J. (2016) Physical and chemical alteration of shales during hydraulic fracturing. Presented at the Goldschmidt Conference, Yokohama, Japan. June 29. [Talk]
43. Dustin, M. K.; Jew, A. D.; Harrison, A. L.; Joe-Wong, C.; Thomas, D. L.; Maher, K.; Brown G. E. Jr.; Bargar, J. R. (2015) Kerogen-hydraulic fracture fluid interactions: reactivity and contaminant release. Presented at the American Geophysical Union Fall Meeting. San Francisco, USA. December 14-18. [Talk]
44. Harrison, A. L.; Jew, A. D.; Dustin, M. K.; Joe-Wong, C.; Thomas, D. L.; Maher, K.; Brown, G. E. Jr.; Bargar, J. R. (2015) A geochemical framework for evaluating shale-hydraulic fracture fluid interactions. Presented at the American Geophysical Union Fall Meeting. San Francisco, USA. December 14-18. [Talk]
45. Jew, A. D.; Joe-Wong, C.; Harrison, A. L.; Thomas, D. L.; Dustin, M. K.; Brown, G. E. Jr.; Maher, K Bargar, J. R. (2015) Iron release and precipitation in hydraulic fracturing systems. Presented at the American Geophysical Union Fall Meeting. San Francisco, USA. December 14-18. [Talk]

Presentations

46. Joe-Wong, C.; Harrison, A. L.; Thomas, D. L.; Dustin, M. K.; Jew, A. D.; Brown, G. E. Jr.; Maher, K.; Bargar, J. R. (2015) Coupled mineral dissolution and precipitation reactions in shale-hydraulic fracturing fluid systems. Presented at the American Geophysical Union Fall Meeting. San Francisco, USA. December 14-18. [Talk]
47. Harrison, A. L. ; Jew, A. D.; Dustin, M. K.; Joe-Wong, C.; Thomas, D. L.; Maher, K.; Brown, G. E. Jr.; Bargar, J. R. (2015) A geochemical framework for evaluating shale-hydraulic fracture fluid interactions. Presented at the Stanford Center for Secure Carbon Storage Research Seminar. Stanford, USA. October 21. [Talk]
48. Dustin, M. K.; Jew, A. D.; Harrison, A. L.; Joe-Wong, C.; Thomas, D. L.; Maher, K.; Brown, G. E. Jr.; Bargar, J. R. (2015) Kerogen-hydraulic fracture fluid interactions: reactivity and contaminant release. Presented at the Stanford Synchrotron Radiation Lightsource user's meeting. Stanford, USA. Oct 7-9. [Talk]
49. Harrison, A. L.; Jew, A. D.; Dustin, M. K.; Joe-Wong, C.; Thomas, D. L.; Maher, K.; Brown G. E. Jr.; Bargar, J. R. (2015) A geochemical framework for evaluating shale-hydraulic fracture fluid interactions. Presented at the Stanford Synchrotron Radiation Lightsource User's Meeting, Stanford, USA, Oct 7-9. [Talk]