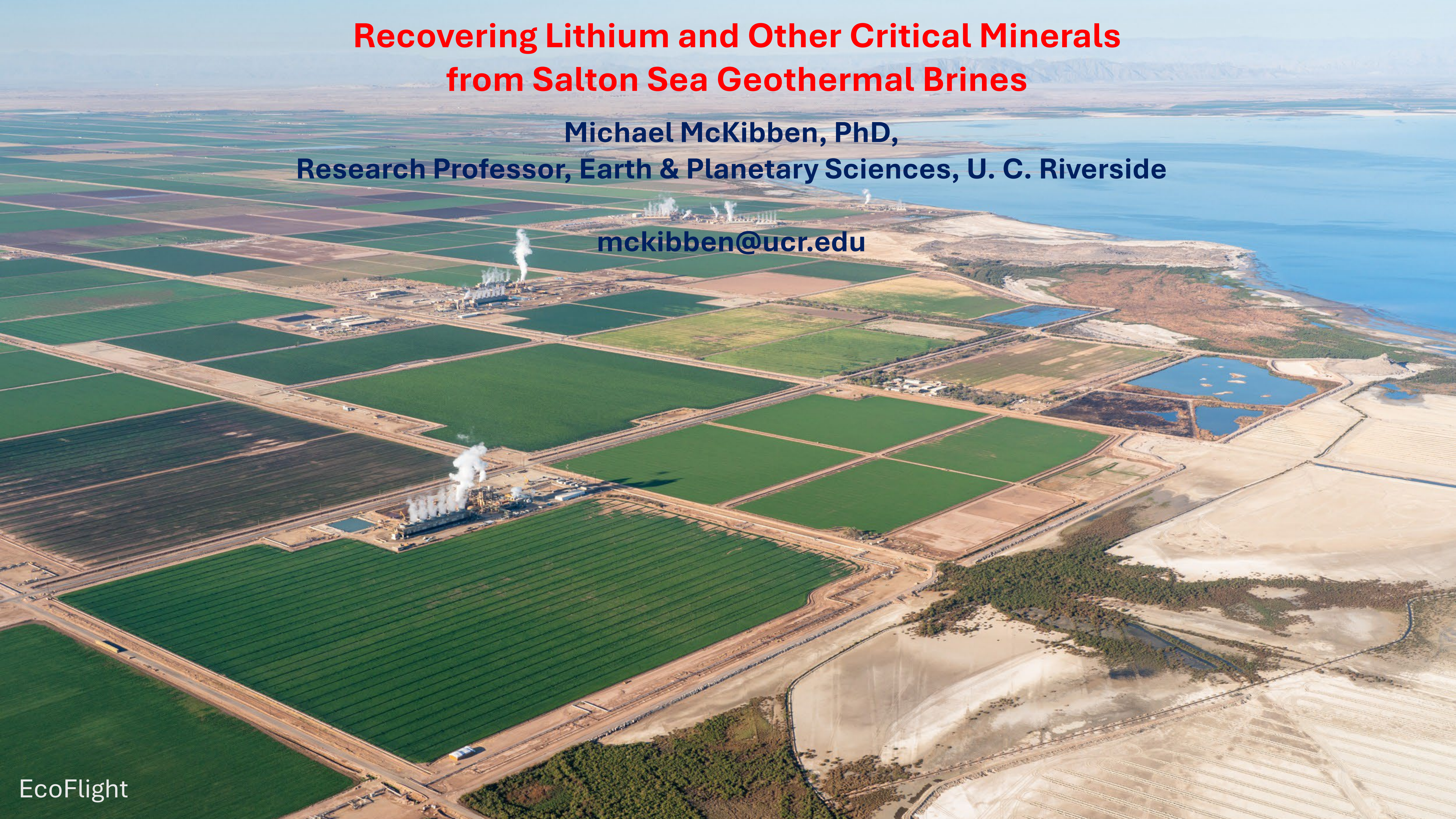
# Recovering Lithium and Other Critical Minerals from Salton Sea Geothermal Brines

Michael McKibben, PhD,
Research Professor, Earth & Planetary Sciences, U. C. Riverside

mckibben@ucr.edu



EcoFlight

# Lithium is one of many metals in the Salton Sea geothermal brines that are of strategic (critical*) interest.

| Field: | Salton Sea |
|---|---|
| Well: | S2–14[b] |
| Temperature (°C)[g] | 330 |
| Depth (m)[h] | 2500–3220 |
| Constituent | |
| Na | 54,800 |
| Ca | 28,500 |
| K | 17,700 |
| Fe | 1,710 |
| Mn | 1,500 |
| $SiO_2$[i] | >588 |
| Zn | 507 |
| Sr | 421 |
| B | 271 |
| Ba | ≈210 |
| Li | 209 |
| Mg | 49 |
| Pb | 102 |
| Cu | 7 |
| Cd | 2 |
| $NH_4$ | 330 |
| Cl | 157,500 |
| Br | 111 |
| $CO_2$[i] | 1,580 |
| $HCO_3$ | NA |
| $H_2S$ | 10 |
| $SO_4$ | 53 |
| TDS | 26.5% |

McKibben & Hardie 1997

| Commodity | Main use | Import reliance | Import sources |
|---|---|---|---|
| **Li 200 ppm** | Batteries | >90% | Argentina, Chile, China |
| **Mn 1500 ppm** | Steel-making | 100% | S. Africa, Australia, Gabon, Georgia |
| **Zn 500 ppm** | Galvanizing | 76% (refined) | China, Peru, Australia |
| **K 18000 ppm** | Fertilizer | 93% | Canada, Russia, Belarus |
| **Sr 400 ppm** | Magnets | 100% | Mexico, Germany, China |
| **Rb 90 ppm** | Quantum computers | 100% | Canada, China |

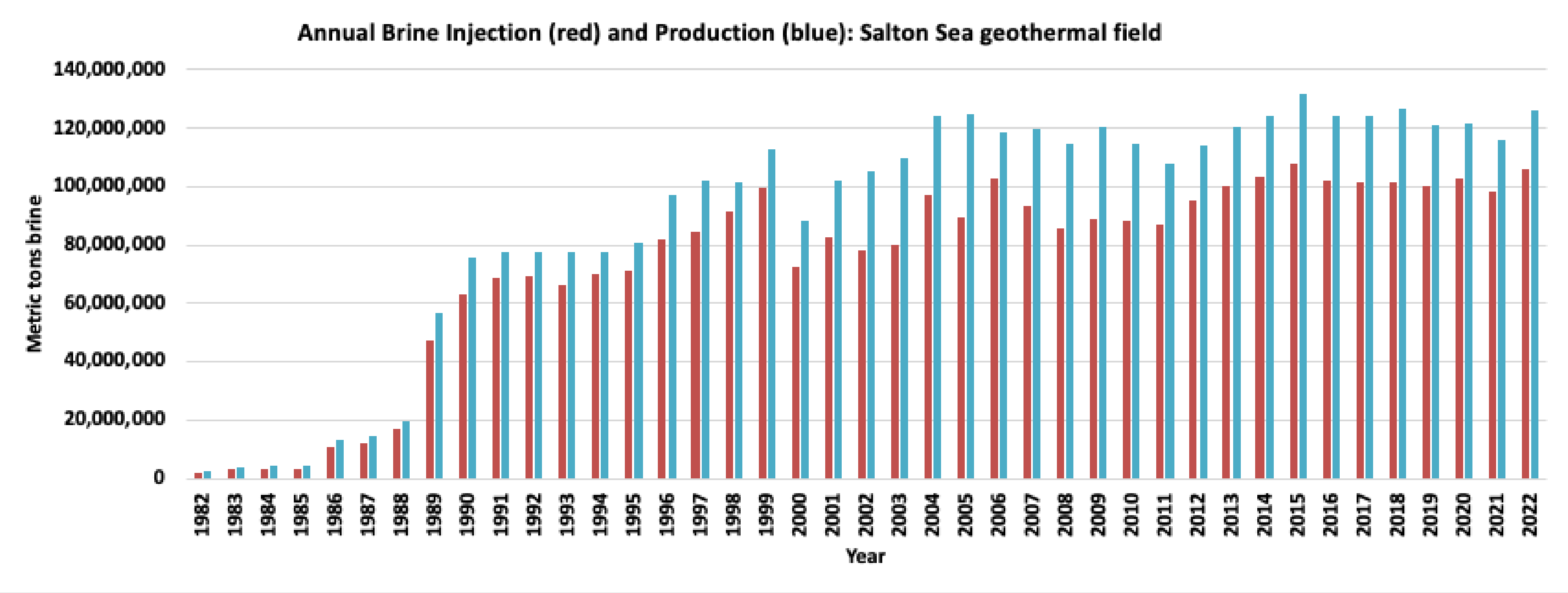
*(Used in defense/technology; supplies are at risk (high import reliance) and the main source nations are our adversaries).

UC RIVERSIDE

# Long-term consistency in brine and Li production (10 power plants)

- Annual Li production = mass of brine × Li conc. × recovery efficiency for the current 400 MWe capacity field.
- Using **20-year avg. of brine production** (**120,000,000 metric t/y**), 200 ppm Li, and a recovery factor of 90%, 21,600 metric tons/y Li metal (**115,000 metric tons/y LCE**) could be recovered **now** (**3.6 M EVs/y**).
- If field expands from 400 to max of ~3000 MWe, production could reach ~**863,000 mt/y LCE** (**27 M EVs/y**).
- For comparison, global Li production in 2024 was **1,276,000 mt/y LCE** (USGS).

Salton Sea Geothermal Field production and injection data from CA Dept. of Conservation




**Dobson et al., 2023**

UC RIVERSIDE

# Revenue potential from additional brine minerals (10 power plants)

Potential metric tons of metals per year at 90% recovery efficiency:

| Metal | ppm | Rate | % of 2023 US Consumption |
|---|---|---|---|
| Mn | 1500 | 162,000 tpy | 24 |
| Li | 198 | 21,384 tpy | ~67 |
| Zn | 500 | 54,000 tpy | 6 |
| Sr | 421 | 45,468 tpy | 967 |
| K | 17,700 | 1,911,600 tpy | 45 |

**(McKibben & Stringfellow, 2025)**

**All geothermal metal recovery is in the demonstration/testing stage, no commercial production has been attained yet; anticipated within next 2 years.**


CTR

UC RIVERSIDE

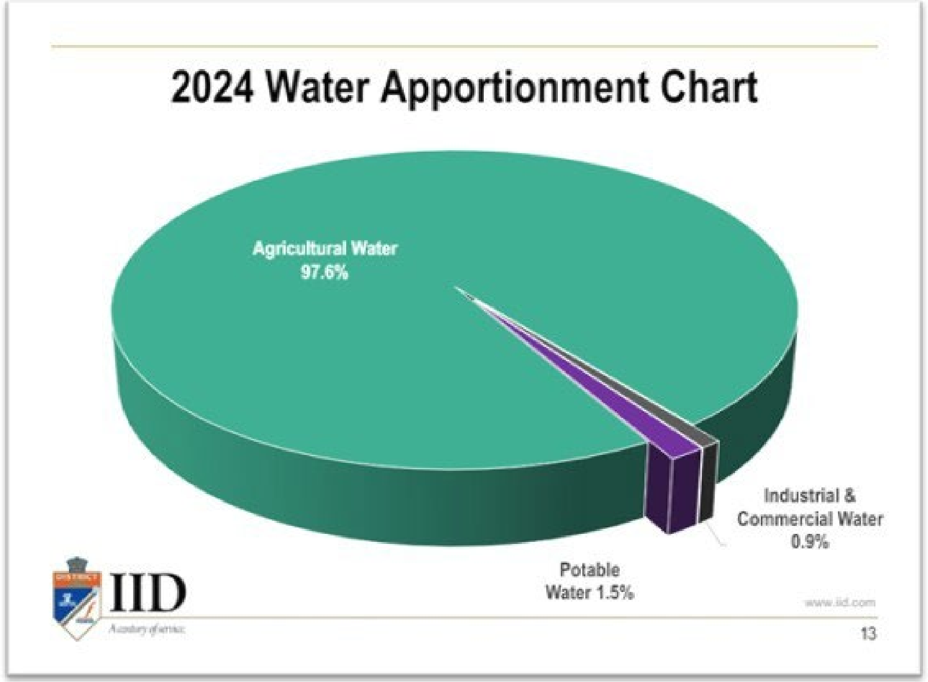
# Annual IID water supply agreements for Li extraction plants

| | | |
|---|---|---|
| ESM - ATLiS project | 3400 acre-feet/year* | 1.11 billion gallons/year |
| CTR - Hell's Kitchen Lithium Phase 1 project | 6500 acre-feet/year* | 2.12 billion gallons/year |

*collectively <0.25% of the total water delivered to customers by IID

BHER is still testing/refining their water use requirements

Industrial water use (1%) pales in comparison to Ag water use (98%).




Busse et al. (2024): water demand for **all currently proposed geothermal production and lithium extraction facilities** only accounts for ~4% of the historical water supply in the region. Regional water allocation will be more impacted by the **proposed cuts** to the region's water allocation from the Colorado River between now and 2050 than by any **expansion** of geother-mal production with associated lithium extraction.

IID also underuses its Lower Basin C.R. compact allocation of 3.1M a-f almost every year; in recent years the underuse (underrun) was ~ 100,000 a-f annually, far more than that needed to supply planned annual geothermal and lithium needs for the foreseeable future.

MacDonald et al. (in press): a predictive model for water use by Li extraction from the geothermal brines; will be tested and calibrated once commercial Li production begins.

UC RIVERSIDE

## Advantages of producing critical minerals from geothermal brines as opposed to salars and hard rock deposits:

- No new drilling, blasting, grinding, rock leaching, tailings piles, pumping or evaporation ponds.
- Brine handing infrastructure is already capitalized and in place.
- Low areal footprint (~ 50 acres per extraction plant).
- Other mineral co-products (Mn, Zn, K) can add to the revenue steam.
- The brine reservoir is contiguous and relatively uniform in its composition and metal content. Production has been stable for over 40 years.
- Can self-supply low-carbon renewable electricity from power plants.
- Can self-supply carbonate from $CO_2$ in steam for making LCE.
- Can self-supply fresh water for Li processing from clean steam condensate.
- Spent brine reinjection into the hot reservoir and fast reaction with Li-bearing host rocks may enhance resource sustainability (under evaluation).

UC RIVERSIDE

# References

Busse, M.M., McKibben, M.A., Stringfellow, W., Dobson, P. and Stokes-Draut, J.R. (2024), *Impact of Geothermal Expansion and Lithium Extraction in the Salton Sea Known Geothermal Resource Area (SS-KGRA) on Local Water Resources*; Environmental Research Letters; https://iopscience.iop.org/article/10.1088/1748-9326/ad6a73/meta

Dobson, P., Araya, N., Brounce, M., Busse, M., Camarillo, M.K., English, L., Humphreys, J., Kalderon-Asael, B., McKibben, M., Millstein, D. and Nakata, N. (2023) *Characterizing the Geothermal Lithium Resource at the Salton Sea*. Lawrence Berkeley National Laboratory (LBNL), Berkeley, CA (United States), LBNL-2001557, 371 pp. https://escholarship.org/uc/item/4x8868mf

MacDonald, L., Gunawardhana, L., Camarillo, M.K., Stringfellow, W., McKibben, M.A., Dobson, P., Nico, P., Schill, E., Busse, M.M., (2025) *Pretreatment of Geothermal Brine for Lithium Recovery*; Geothermal Rising Conference; Reno, NV (submitted).

McKibben, M.A. and Stringfellow, W.T. (2025) *Recovery of Minerals from Geothermal Brines*, Ch. 20 In Geothermal Power Generation, 2nd Edition (Ronald DiPippo, Andrew Chiasson, and Luis Carlos Gutiérrez-Negrín, editors) Elsevier. https://doi.org/10.1016/B978-0-443-24750-7.00029-4