



Magmatic Toxicity on the Ski Slopes? Carbon Dioxide levels across Mammoth Mountain, CA



Fumarole at Mammoth Mtn Ski Area

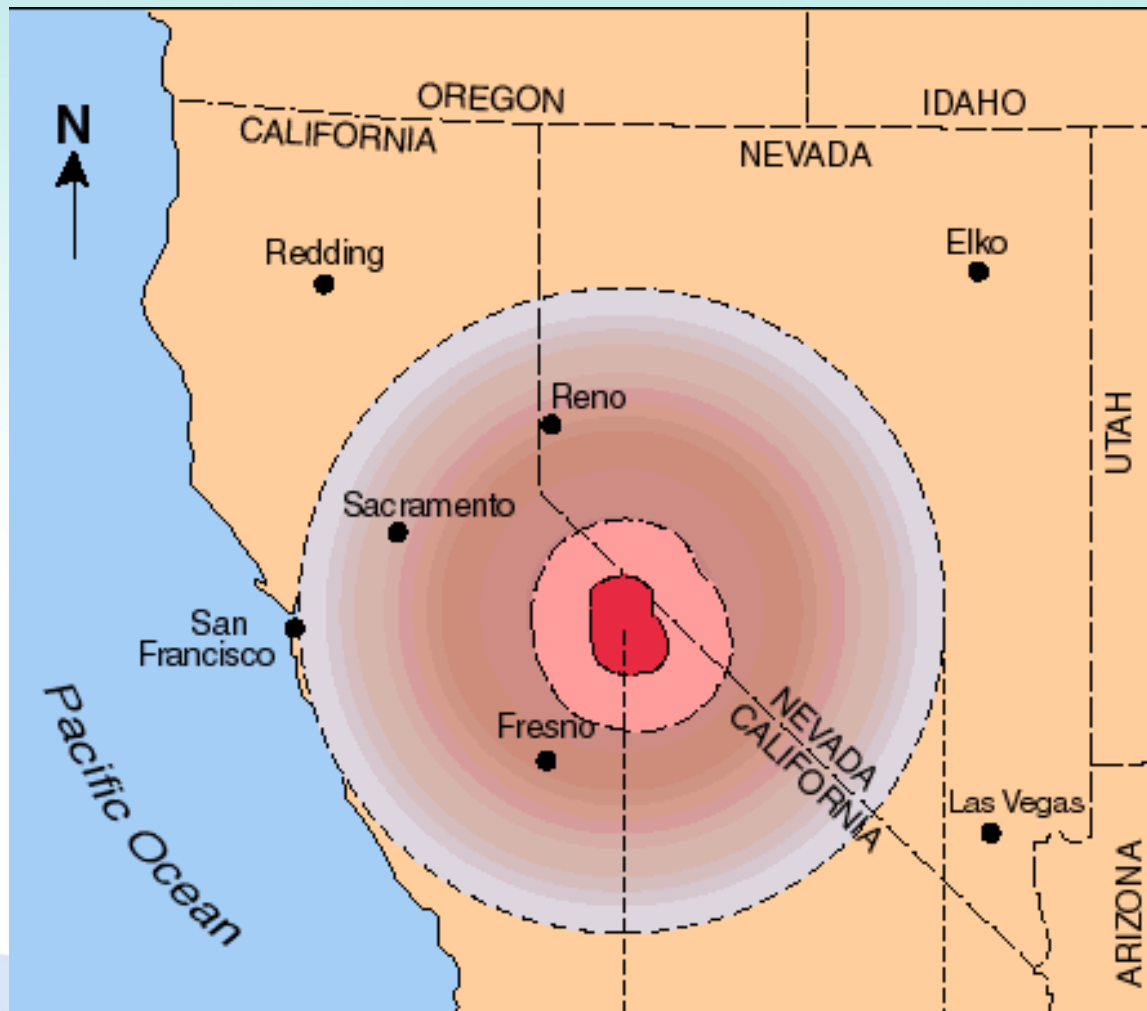
YouTube

mammoth mountain fumerole

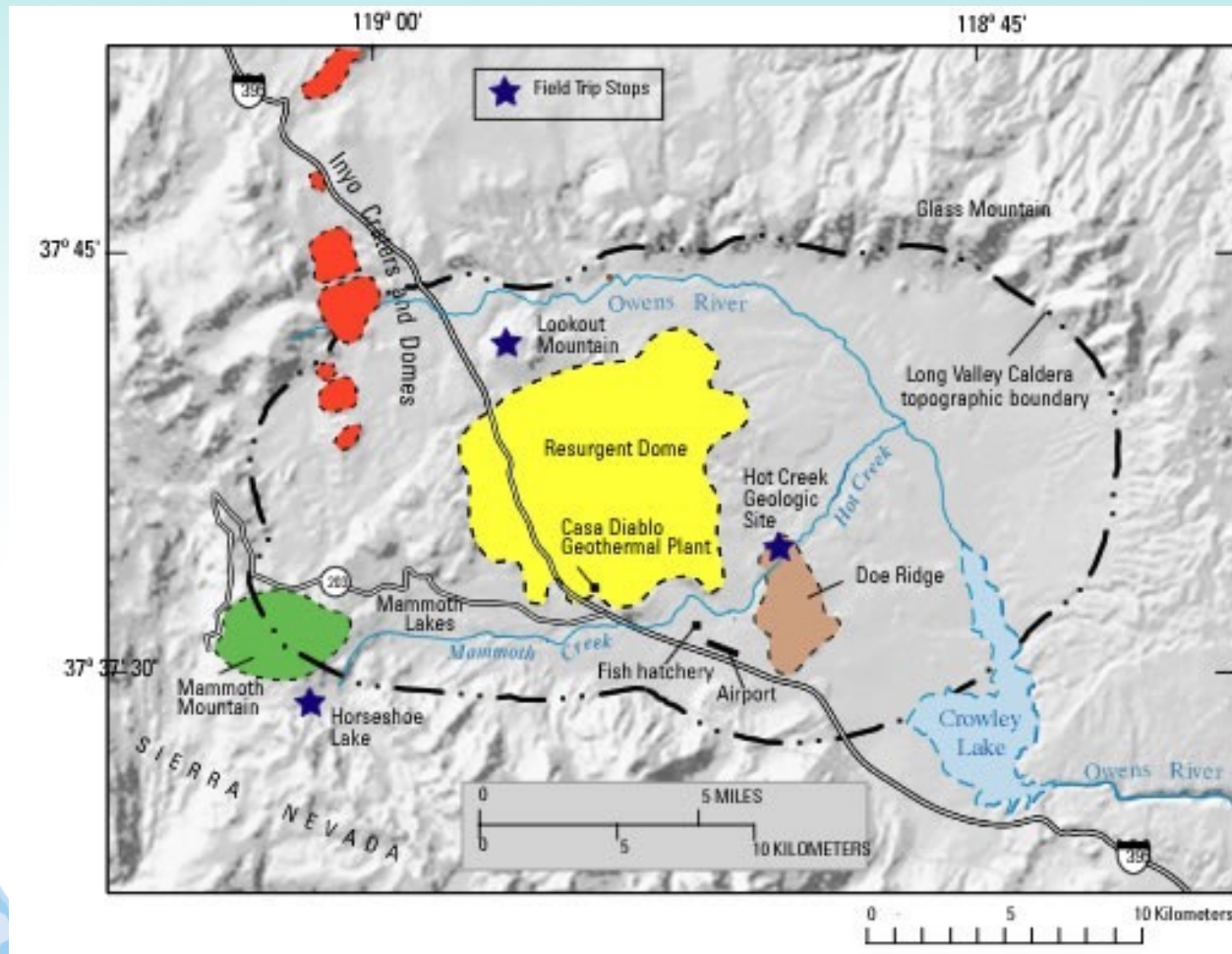


Fumarole on Mammoth Mountain

Regional Map: CA Eastern Sierra



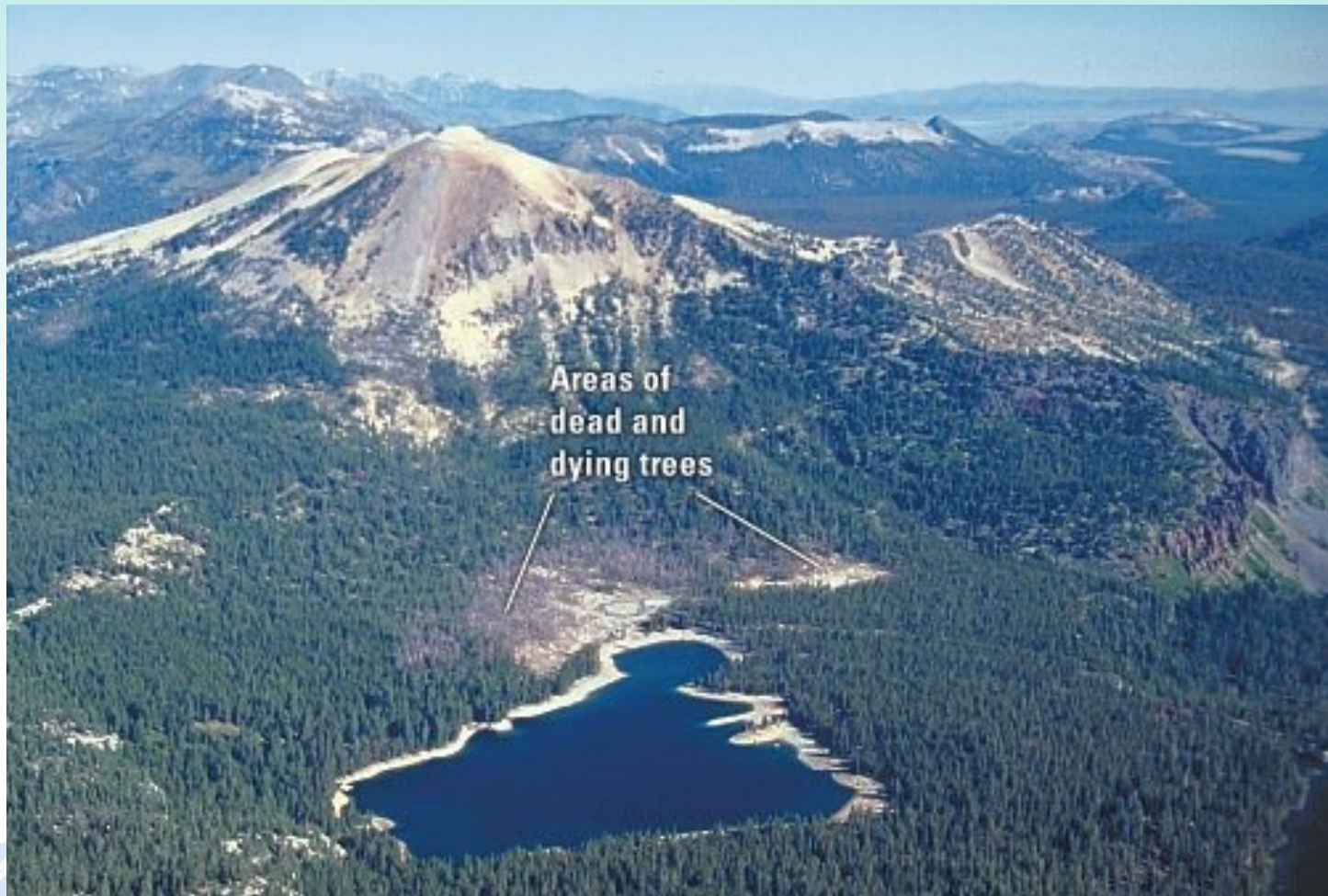
Long Valley Caldera Area



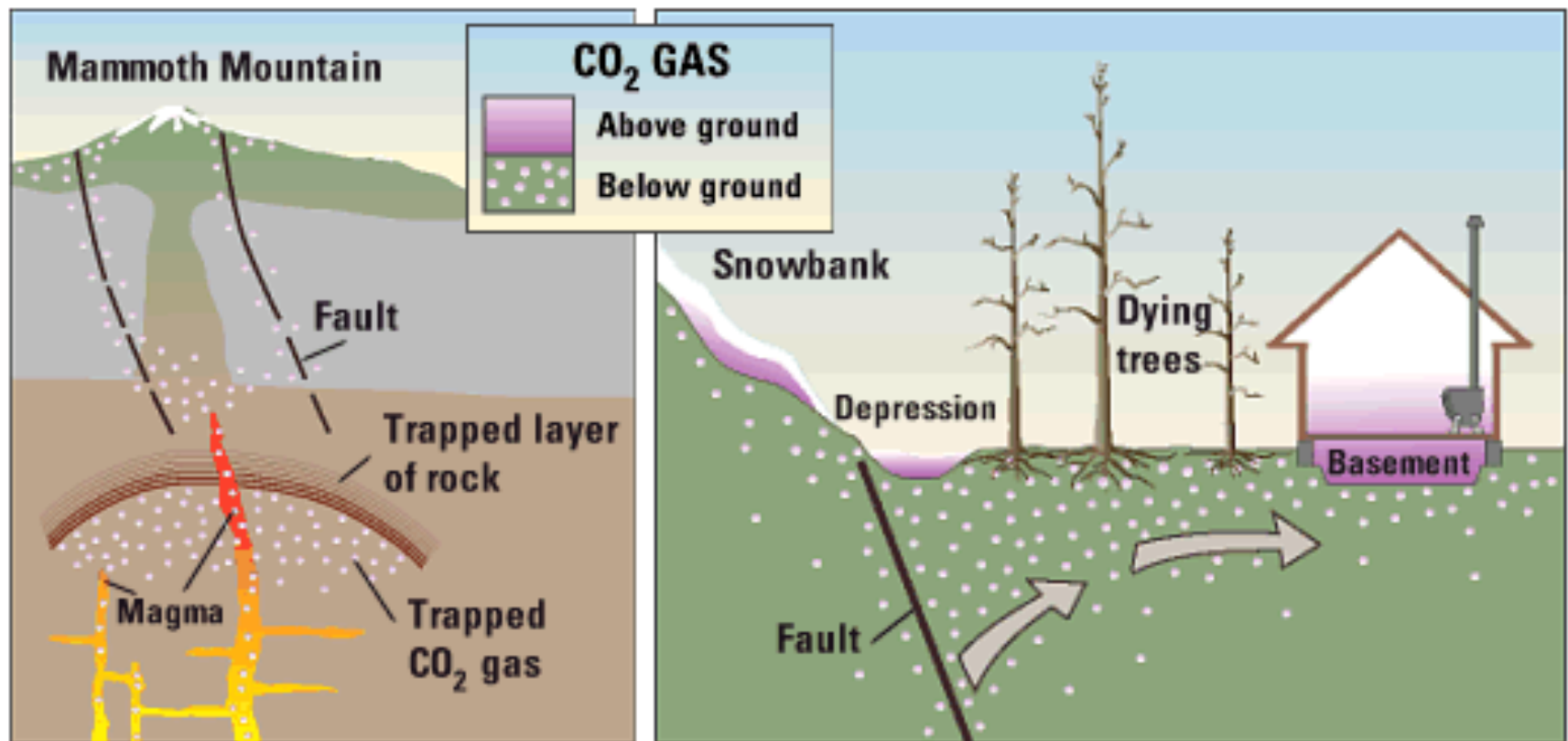
Mammoth Mountain Ski Area



Tree Kill @ Horseshoe Lake, Mammoth Mtn

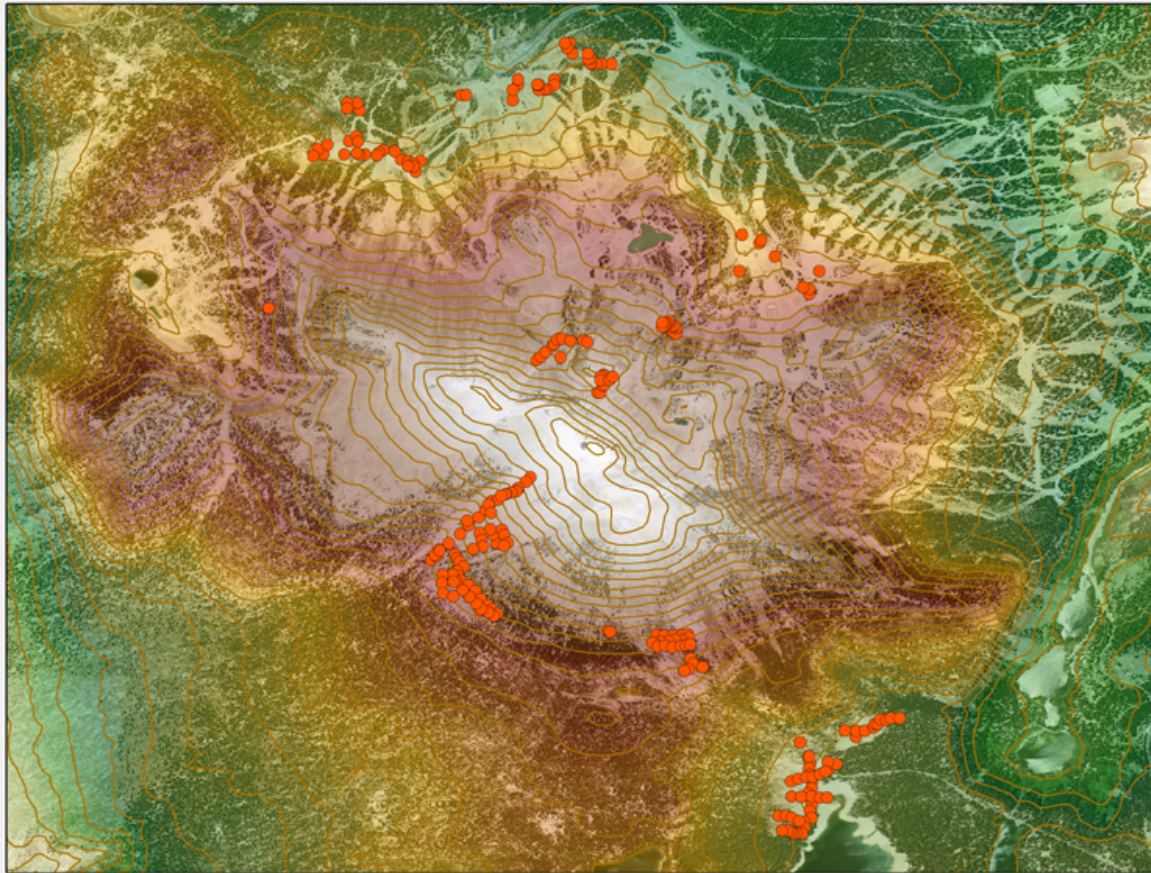


Carbon Dioxide Pathways, Mammoth Mtn



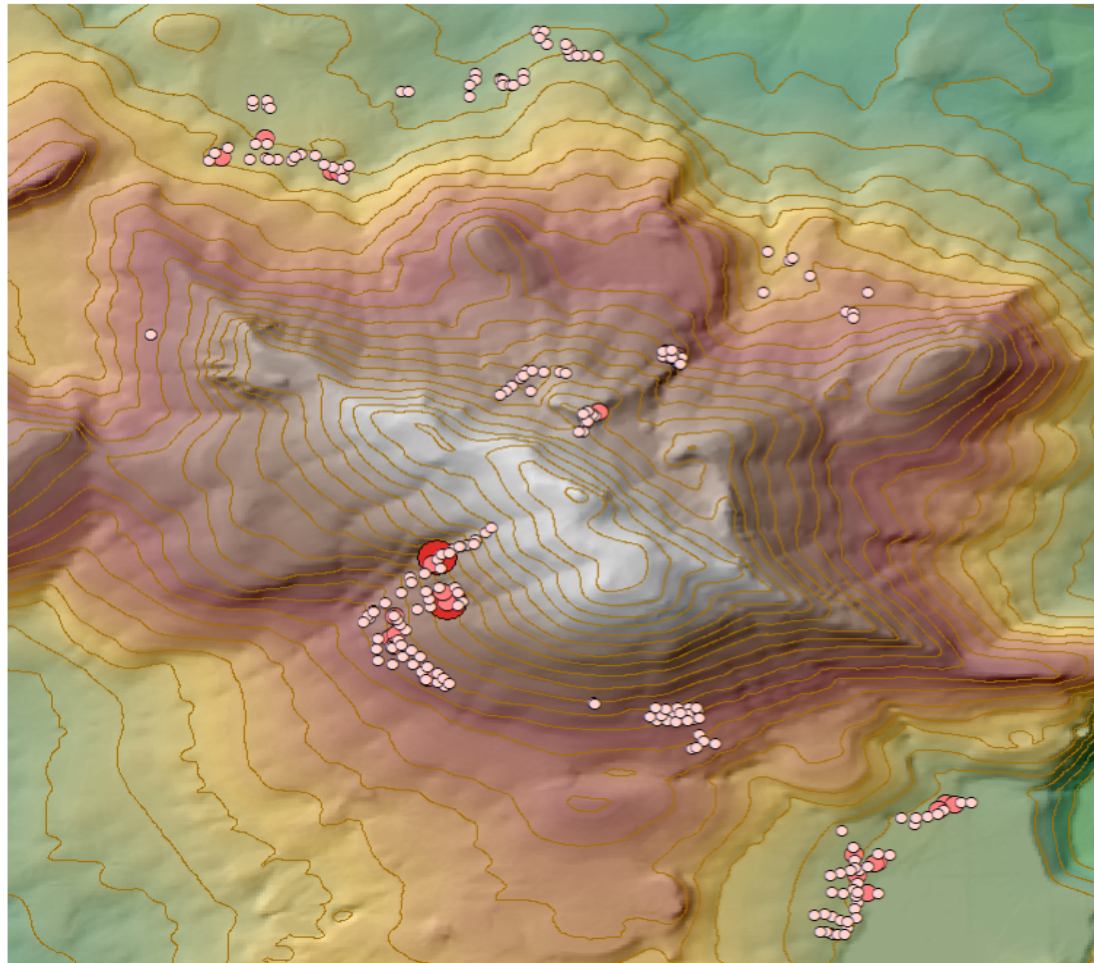
Map of Pt Samples over Elevation & Imagery

Samples of Magmatic Carbon Dioxide Emissions at Mammoth Mountain, CA (1996)



Classified Map of Mammoth CO2 Samples

Samples of Magmatic Carbon Dioxide Emissions at Mammoth Mountain, CA (1996)



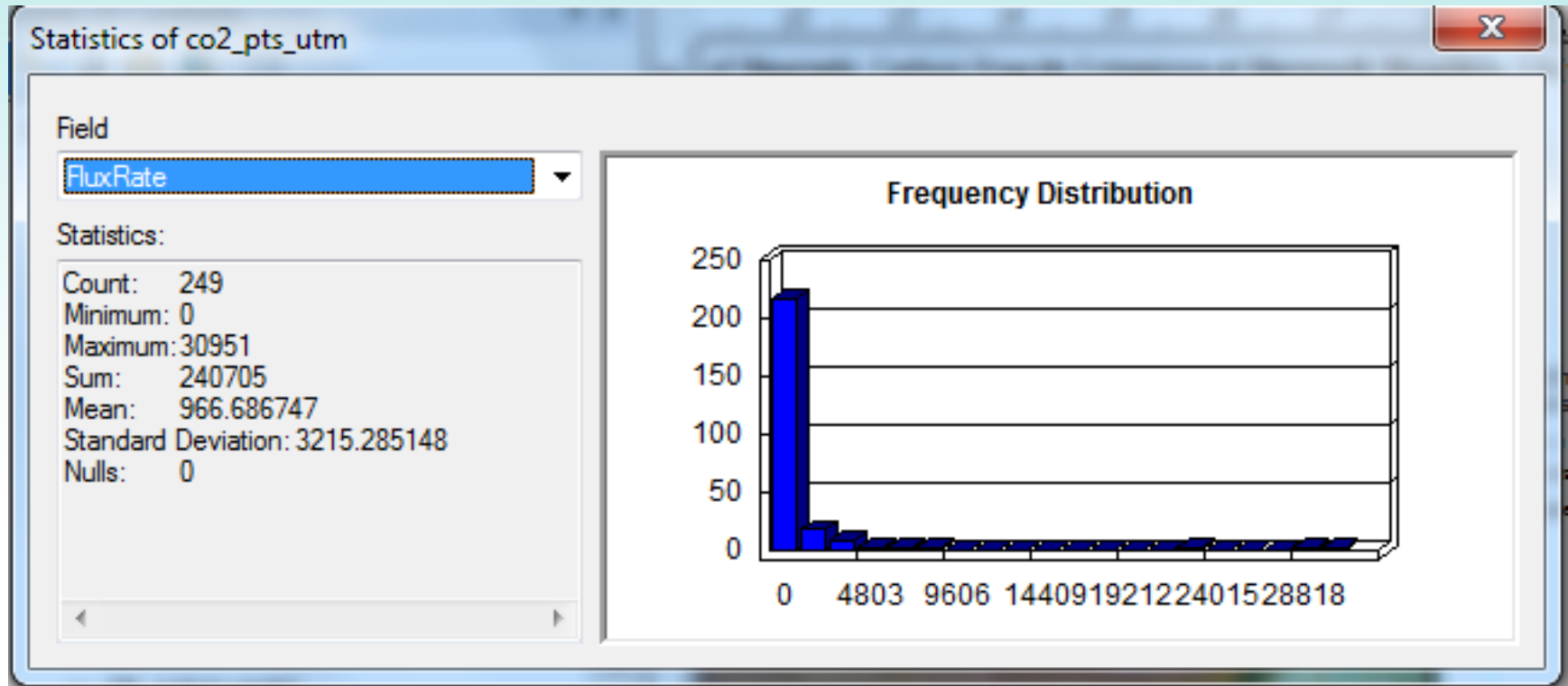
Flux (Emissions Rate)
(grams / m² / day)

- 0 - 1988
- 2109 - 8050
- 22463 - 30951

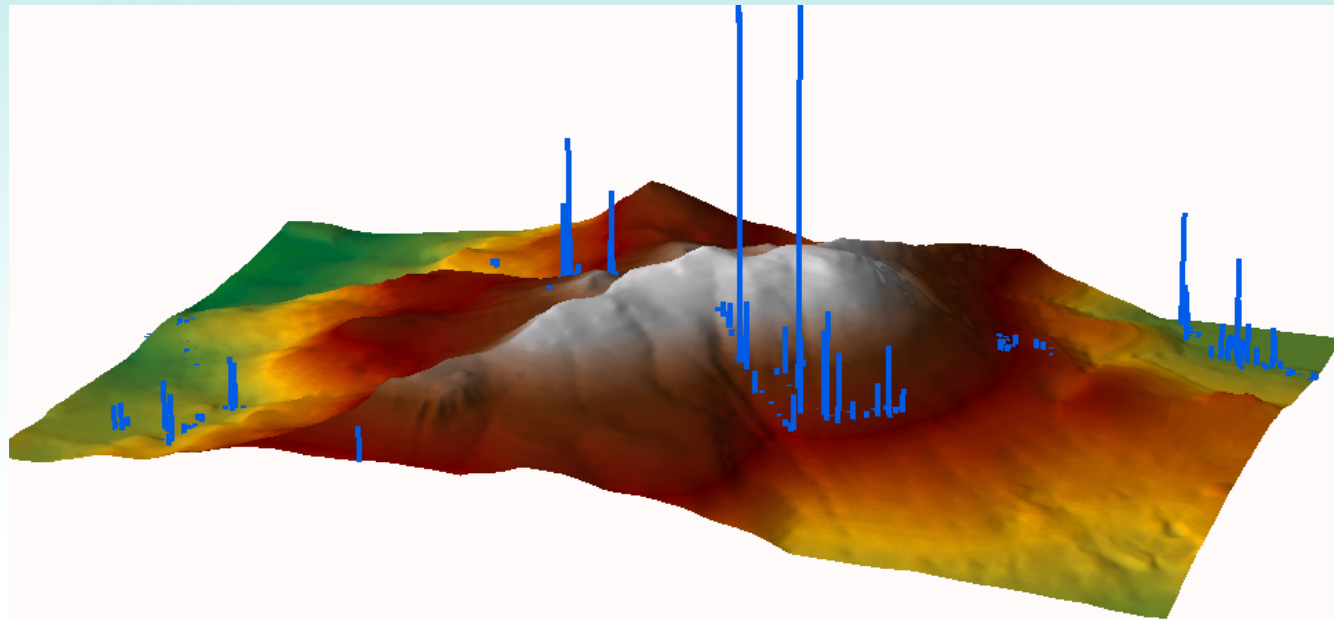
0 0.5 1 Km

Source: U.S. Geological Survey

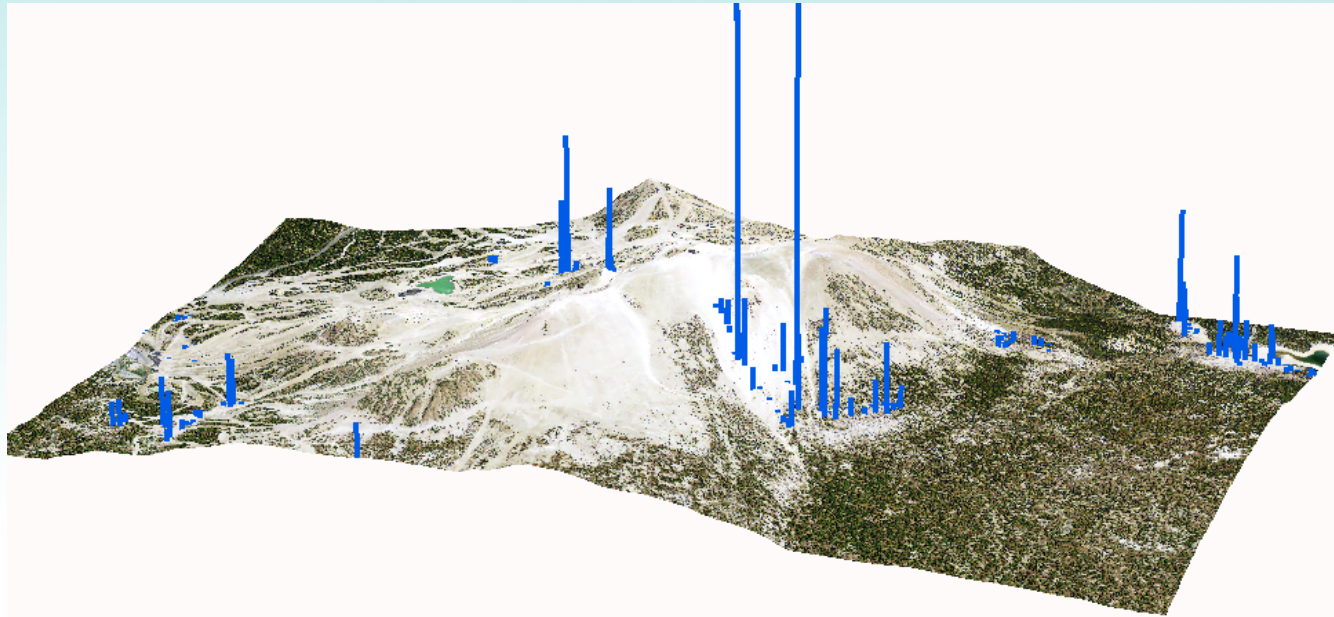
Summary Stats of Mammoth CO2 Samples



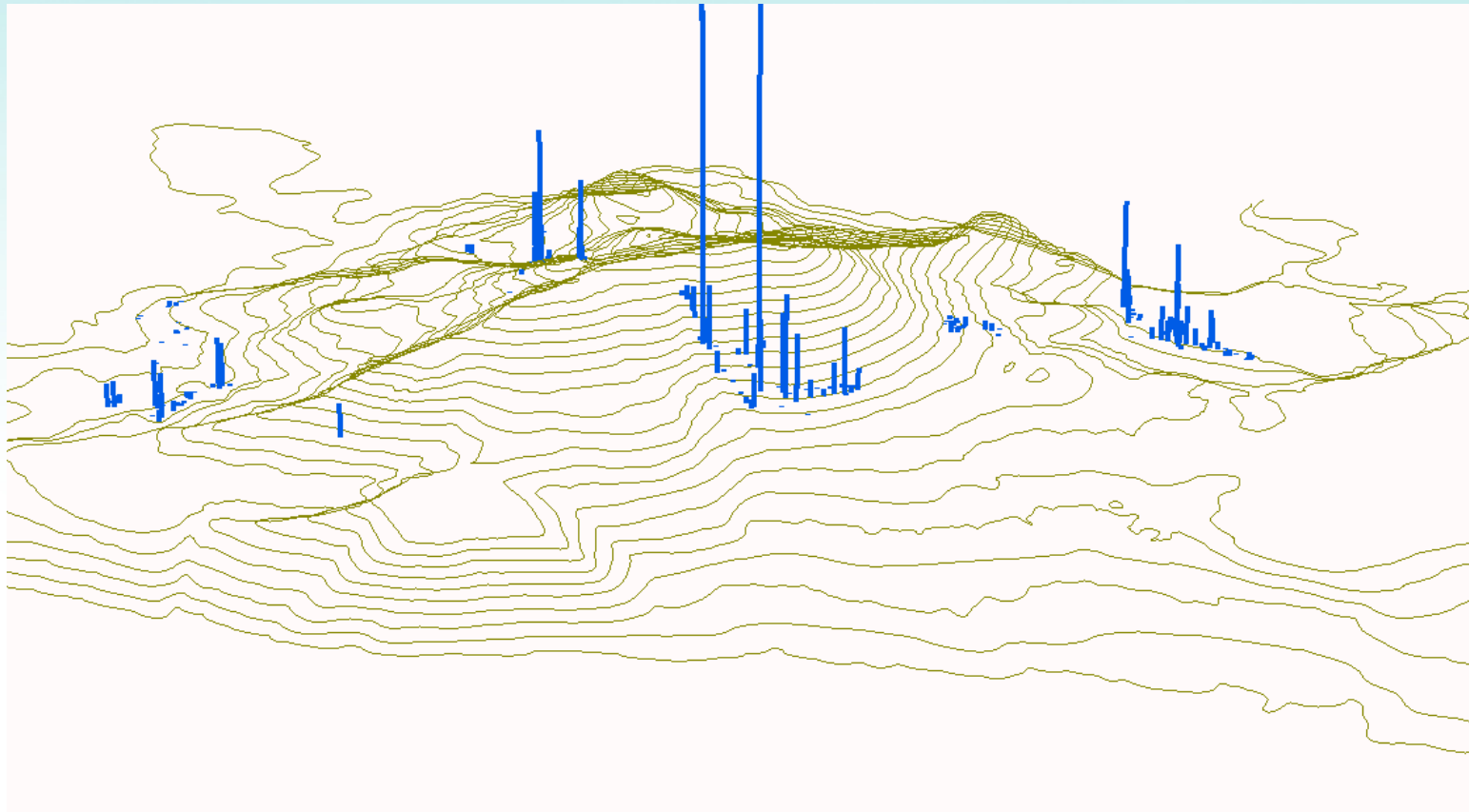
ArcScene Extruded CO2 Values over Elevation



ArcScene Extruded CO2 Values over Imagery



ArcScene Extruded CO2 Values over Contours



Clustered CO2 Pt Dataset confirmed by ANN

Average Nearest Neighbor Summary

Nearest Neighbor Ratio: 0.241901

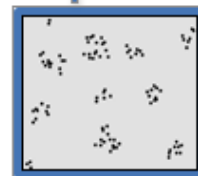
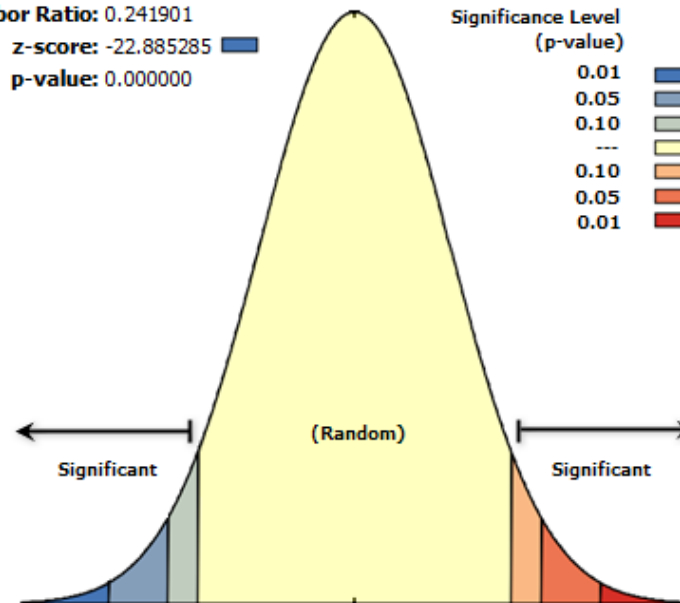
z-score: -22.885285

p-value: 0.000000

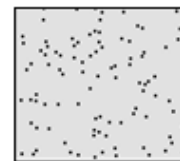
Significance Level
(p-value)

Critical Value
(z-score)

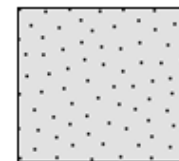
0.01	< -2.58
0.05	-2.58 -- -1.96
0.10	-1.96 -- -1.65
---	-1.65 -- 1.65
0.10	1.65 -- 1.96
0.05	1.96 -- 2.58
0.01	> 2.58



Clustered



Random



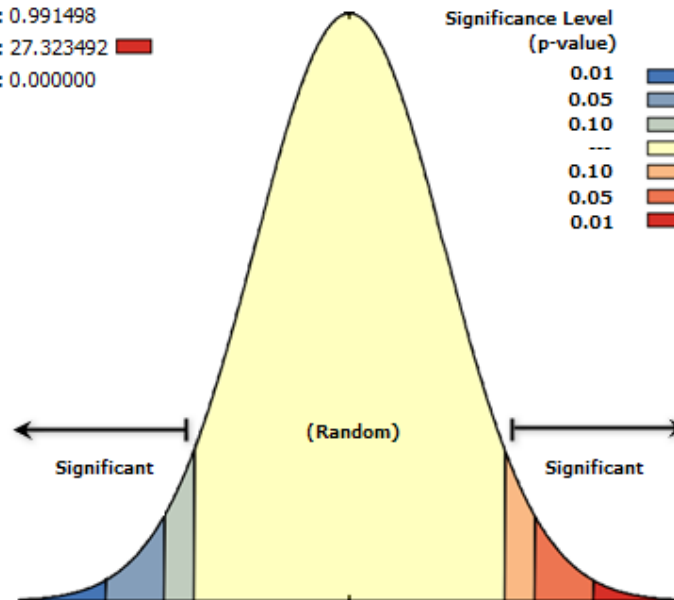
Dispersed

Clustering also confirmed by Morans I

Spatial Autocorrelation Report

Moran's Index: 0.991498
z-score: 27.323492
p-value: 0.000000

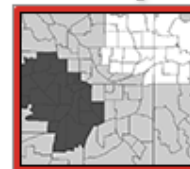
Significance Level (p-value)	Critical Value (z-score)
0.01	< -2.58
0.05	-2.58 - -1.96
0.10	-1.96 - -1.65
---	-1.65 - 1.65
0.10	1.65 - 1.96
0.05	1.96 - 2.58
0.01	> 2.58



Dispersed



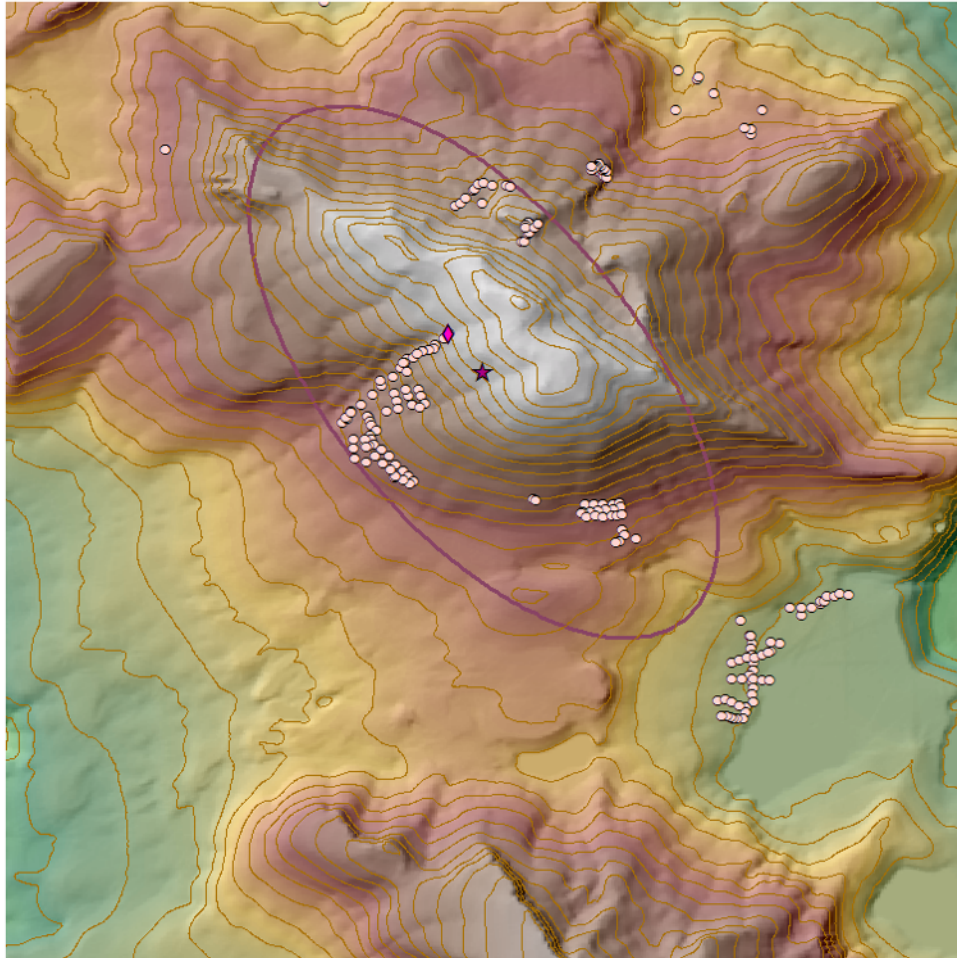
Random



Clustered

Spatial Statistics Weighted by CO2 Flux Rate

Spatial Statistics for Magmatic Carbon Dioxide Emissions at Mammoth Mtn, CA (1996)



Spatial Statistics Weighted by CO2 Flux Rate

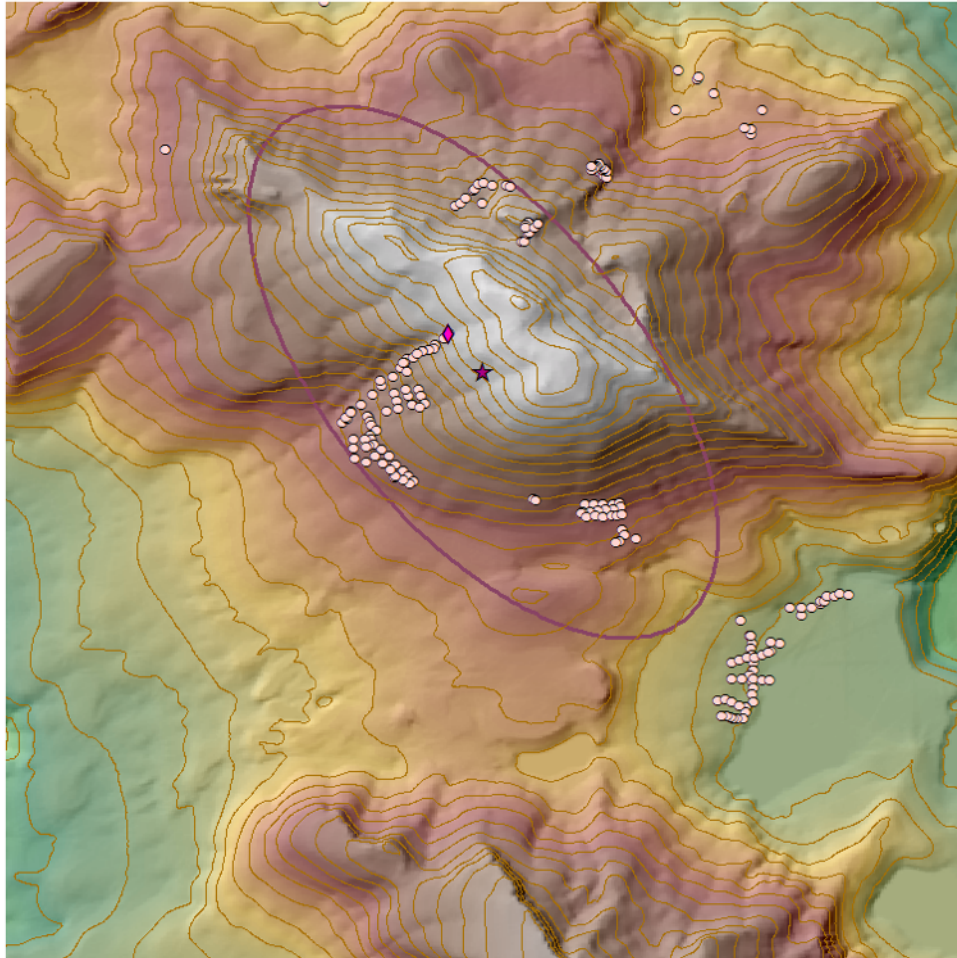
- CO2 samples
- ◆ central feature
- ★ mean center
- ▭ directional distribution

0 0.5 1 Km

Source: U.S. Geological Survey

Spatial Statistics Weighted by CO2 Flux Rate

Spatial Statistics for Magmatic Carbon Dioxide Emissions at Mammoth Mtn, CA (1996)



Spatial Statistics Weighted by CO2 Flux Rate

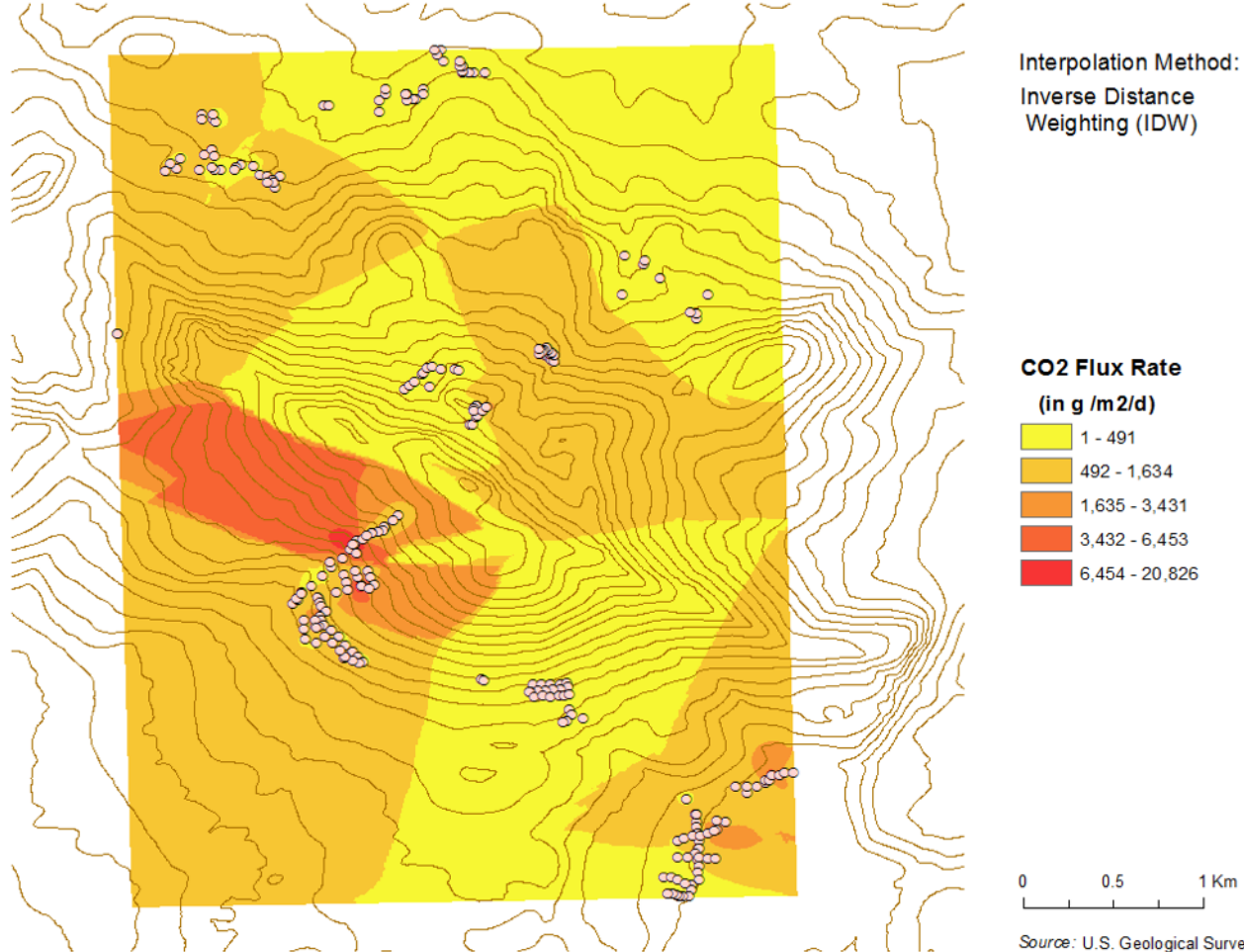
- CO2 samples
- ◆ central feature
- ★ mean center
- ▭ directional distribution

0 0.5 1 Km

Source: U.S. Geological Survey

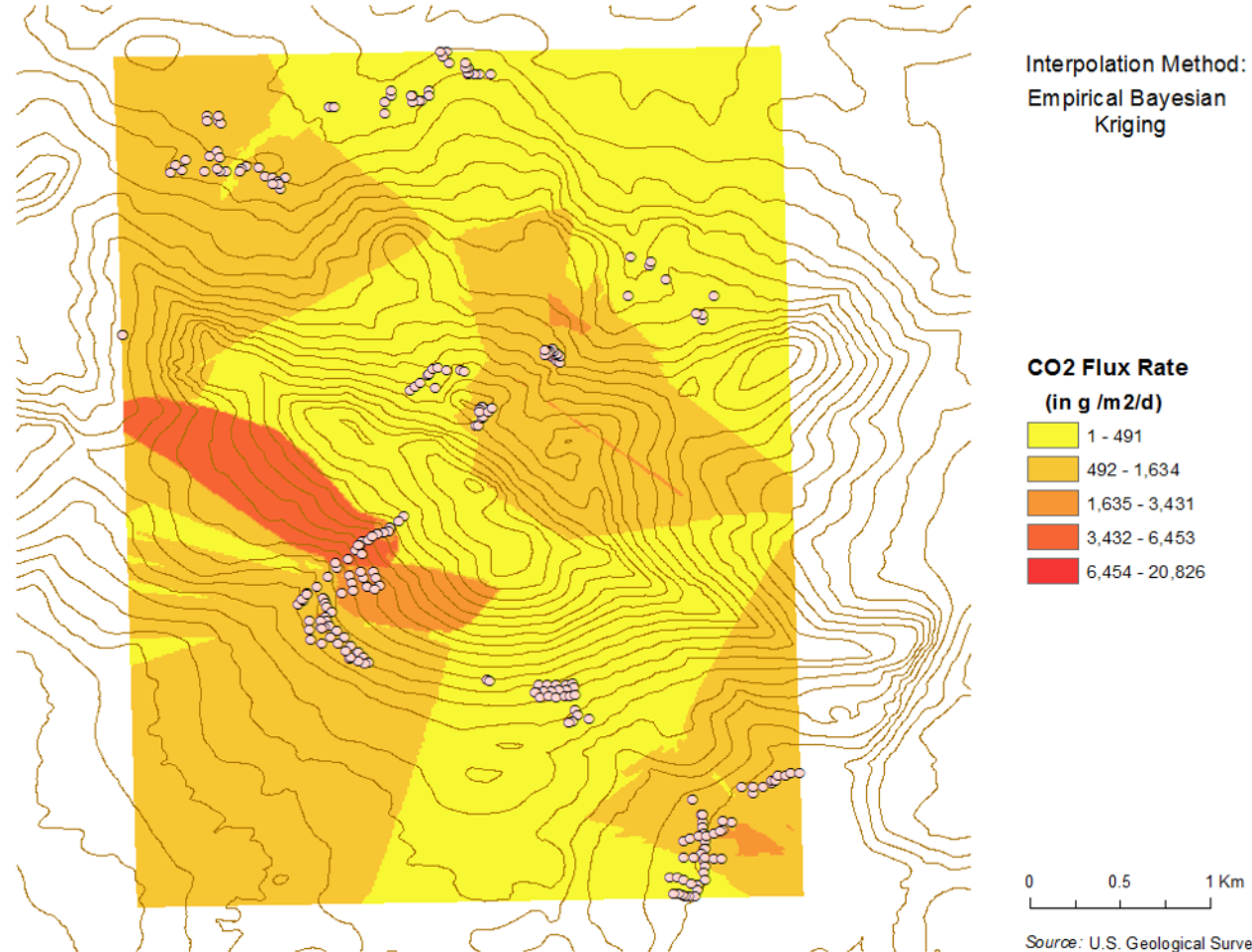
Stat Surface - CO2 Flux - IDW

Surface Interpolation for Magmatic Carbon Dioxide Emissions at Mammoth Mtn, CA (1996)



Stat Surface - CO2 Flux – Bayesian Kriging

Surface Interpolation for Magmatic Carbon Dioxide Emissions at Mammoth Mtn, CA (1996)



Conclusions

- > Moderately-elevated flux rates of CO₂ emissions exist on some areas of Mammoth Mtn - esp near Chair 12 and the Fumerole area.
- > Highest rates of CO₂ flux exist on the “back side” of Mammoth Mtn (not in-bounds) at high elevations.
- > CO₂ emissions phenomenon difficult to model (clustered data samples, high mutli-factor variability)

Further Research

- > Use CO2 soil concentration data from USGS to produce probability maps that show where levels exceeded the 10% mark that is potentially fatal to humans.

