

Spatial variability of Fe, Cu, Mn, Pb and Ba of sediments within the Chihuahuan Desert, Mexico

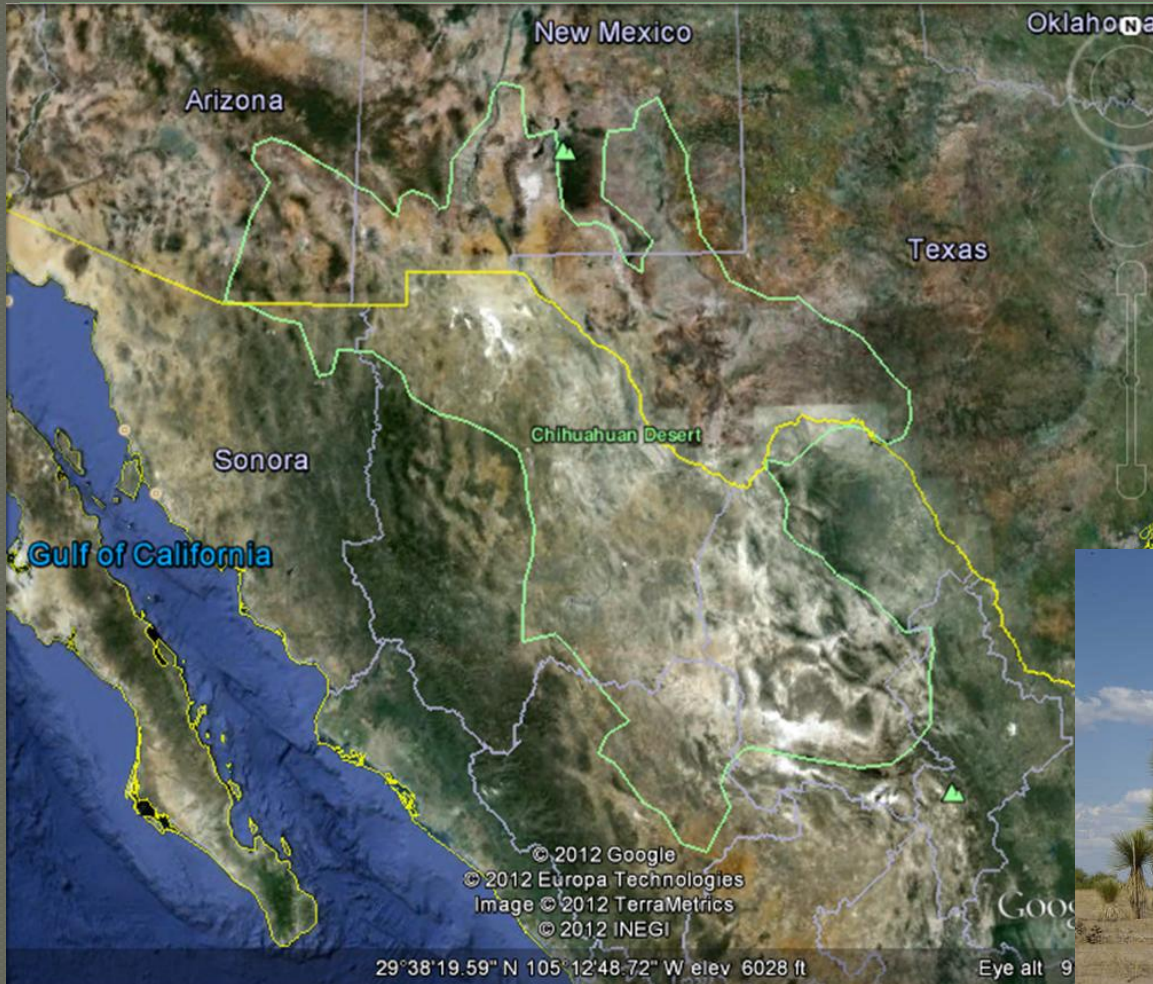
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Chihuahuan Desert



*Area, 362,600 km²
(140,001 sq mi)
2nd largest in N. America
Elevated Plateau
600–1,675 m elev.*



Exploratory Data Analysis (EDA) was applied to sediment geochemical data in order to discriminate between background and anomalous concentrations and to identify possible sources of the anomalous values and their pattern of dispersion.



Dust storm near Delicias
(major agricultural center)

DATA CONSISTS OF 2,914 SEDIMENT DATA COLLECTED BY SGM (SERVICIO GEOLOGICO MEXICANO) AND 12 COLLECTED BY THE AUTHOR. THE AREA COVERED IS ABOUT 85,000 Km²



First European ca. 1528



Cathedral of Chihuahua,
built 1726-1757

Long history of mining :
gold, silver, lead, iron, perlite, barite

Most mines are hydrothermal type deposit.

Many have been abandoned. However, a few
operating mines remain. Within the study
area, operating mines include:

- San Antonio – Ag, Pb (Au)
- Bismark – Pb, Zn
- Naica – Pb, Zn
- La Perla - Fe
- Las Fortunas – Ba
- Cerro Prieto - Ba

Exploratory Data Analysis (EDA)

John W Tuckey (1977); EJM Carranza (2009)

Emphasis is placed on using data to suggest hypotheses,
instead of statistical hypothesis testing
(confirmatory data analysis)

A geochemical data set containing more than one population (as it is the case of the analysis of natural geochemistry affected by different types of exposed rocks) does not exhibit normal distribution, for which ± 2 SDEV to estimate anomalous values does not apply anymore.

One graphical technique used in EDA is boxplot (box diagram)

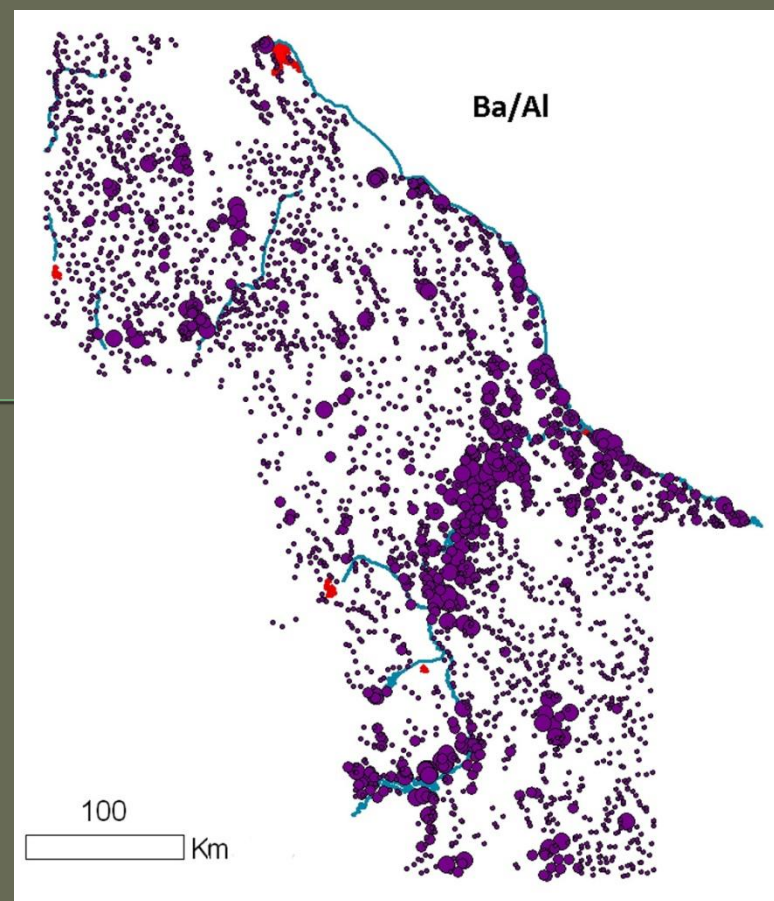
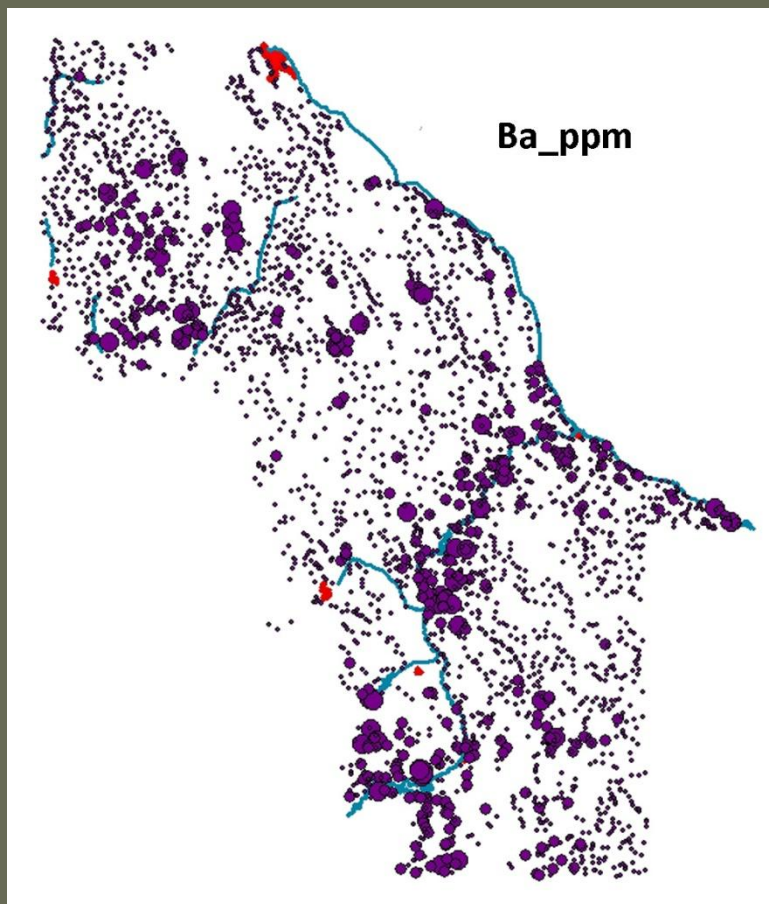
Boxplot Features

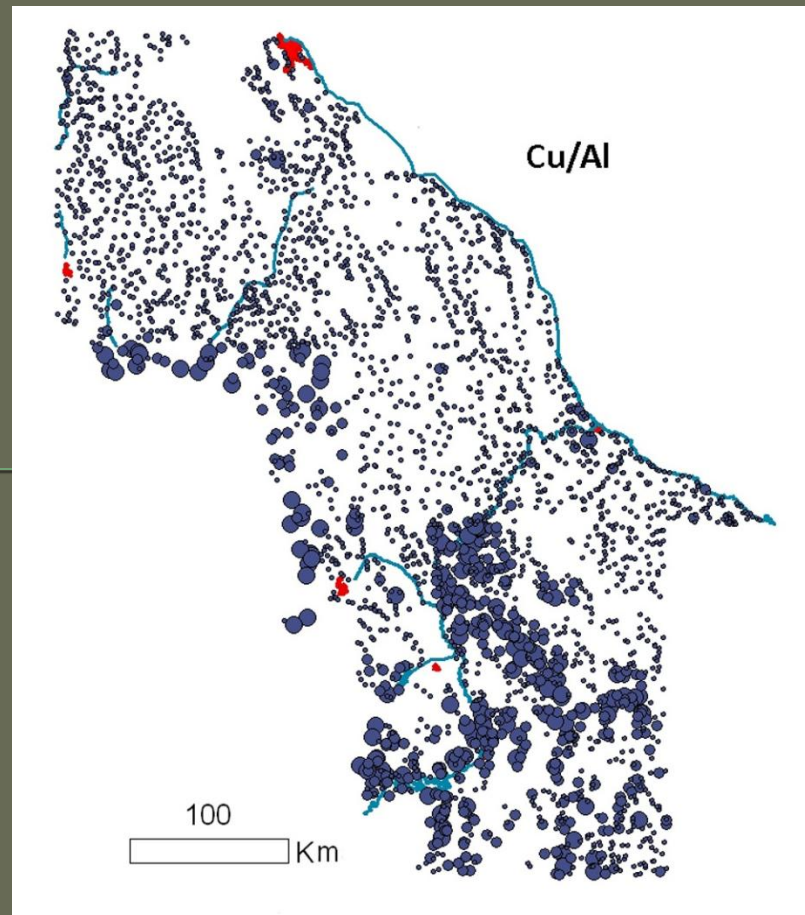
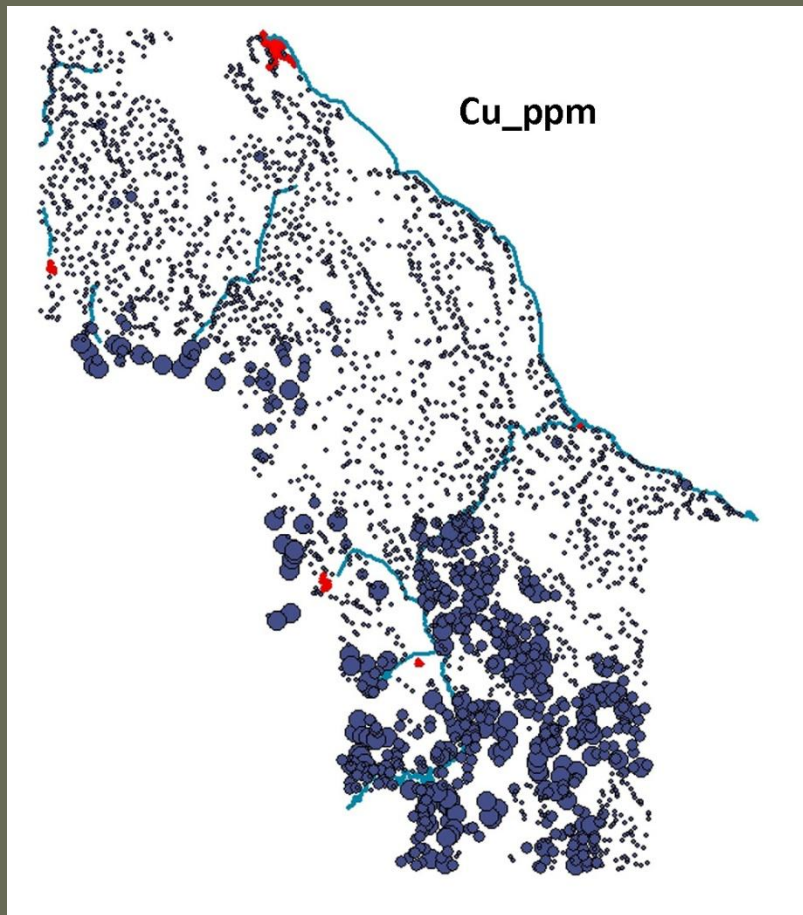


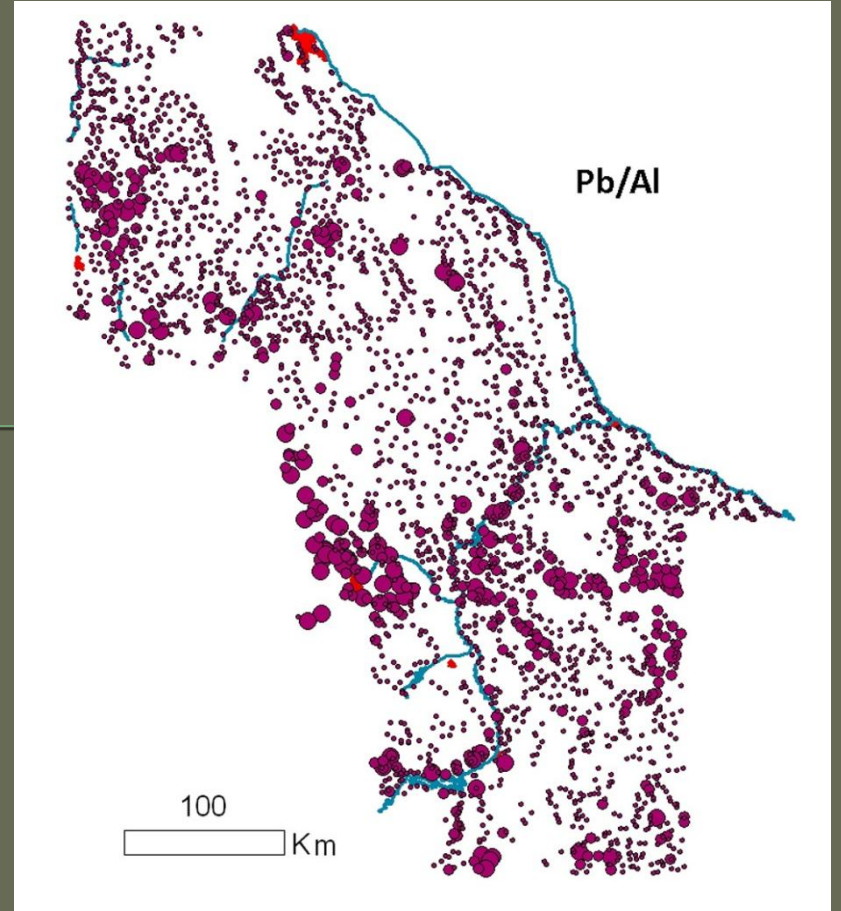
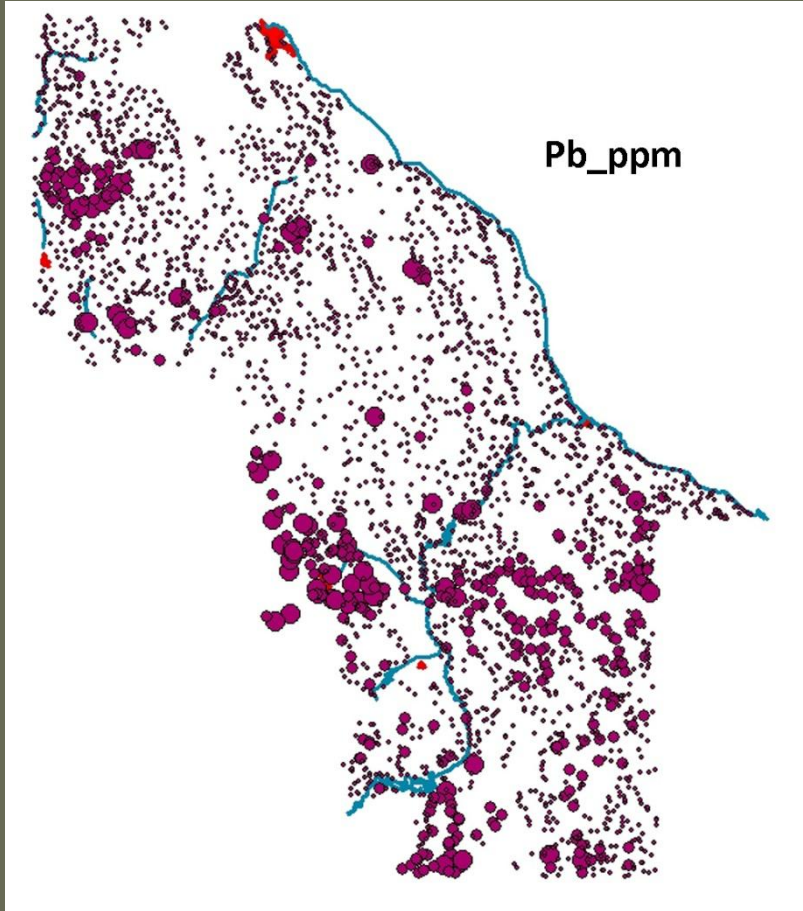
Data values	Mapping Symbols	Anomaly
$Q1 + 3 (IQR) =$ upper outer fence	●	Extreme +
$Q1 + 1.5 (IQR) =$ upper inner fence	●	Mild +
$Q1 =$ first quartile = upper hinge		
$Q2 =$ second quartile = Median	●	Non
$Q3 =$ third quartile = lower hinge		
$Q1 - 1.5 (IQR) =$ lower inner fence		Mild -
$Q1 - 3 (IQR) =$ lower outer fence		Extreme -

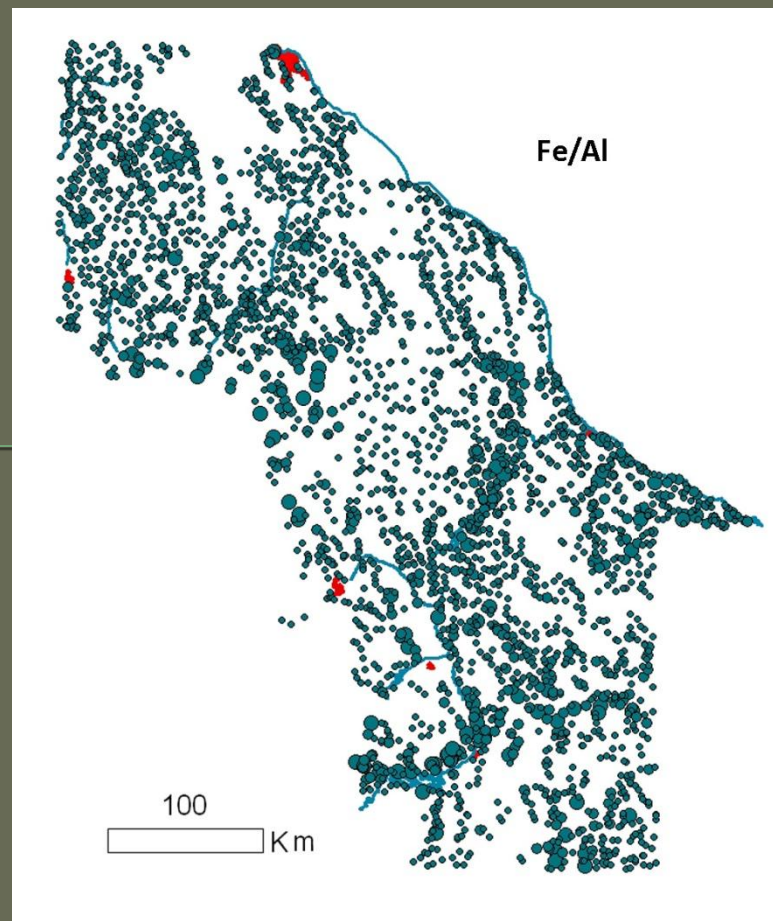
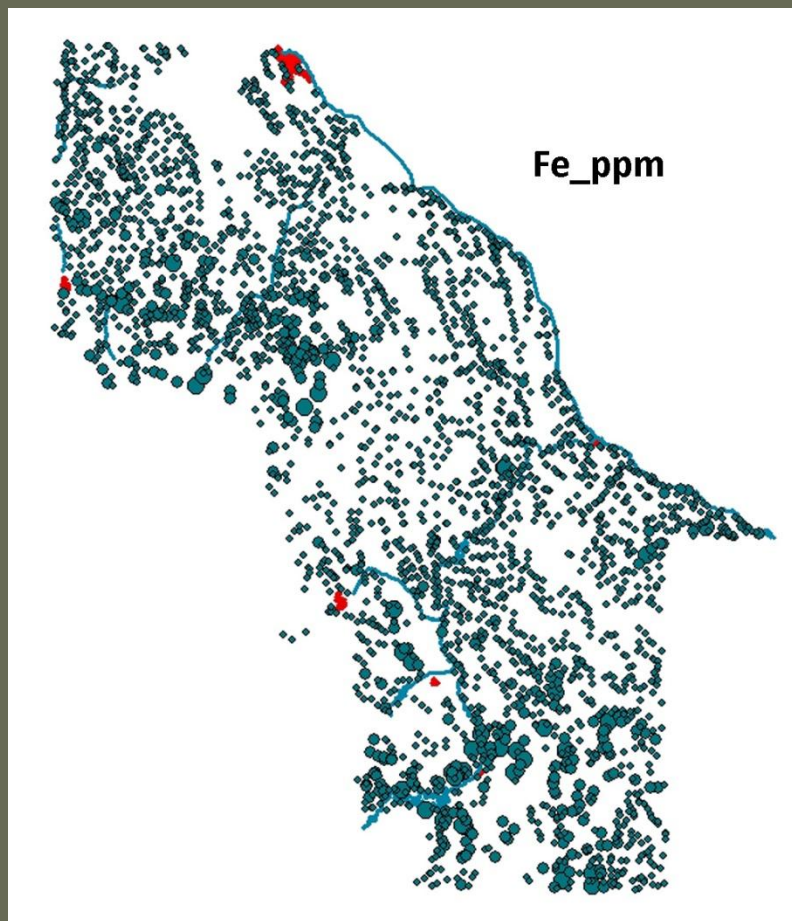
Note: hinge width = IQR = $(Q3 - Q1)$

Normalized vs. Non-normalized Concentrations









High correlation Fe – Mn; $R^2 = 0.61$

Operating Fe, Ba, Cu, and Pb Mines

Operating:

San Antonio Ag, Pb

La Perla, Fe

Bismark, Pb, Zn

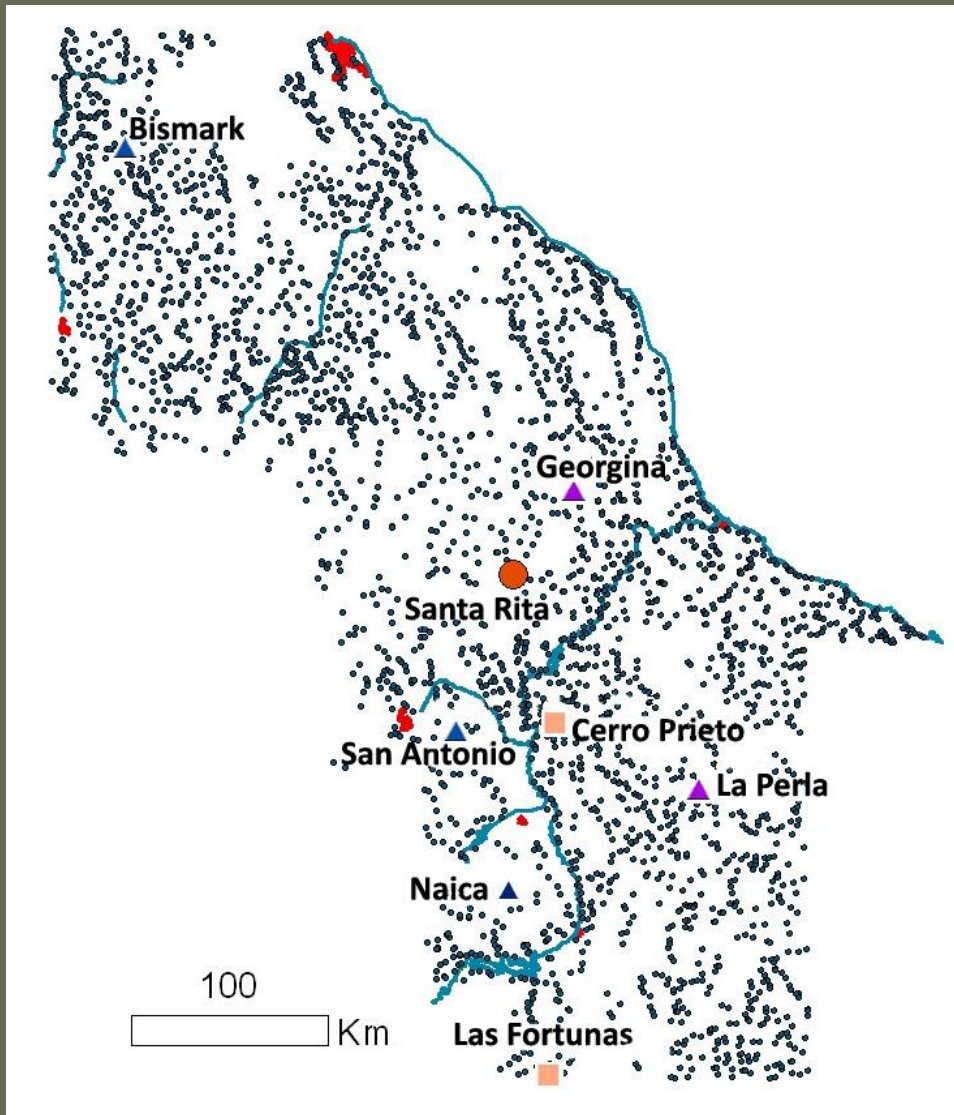
Cerro Prieto, Ba

Las Fortunas, Ba

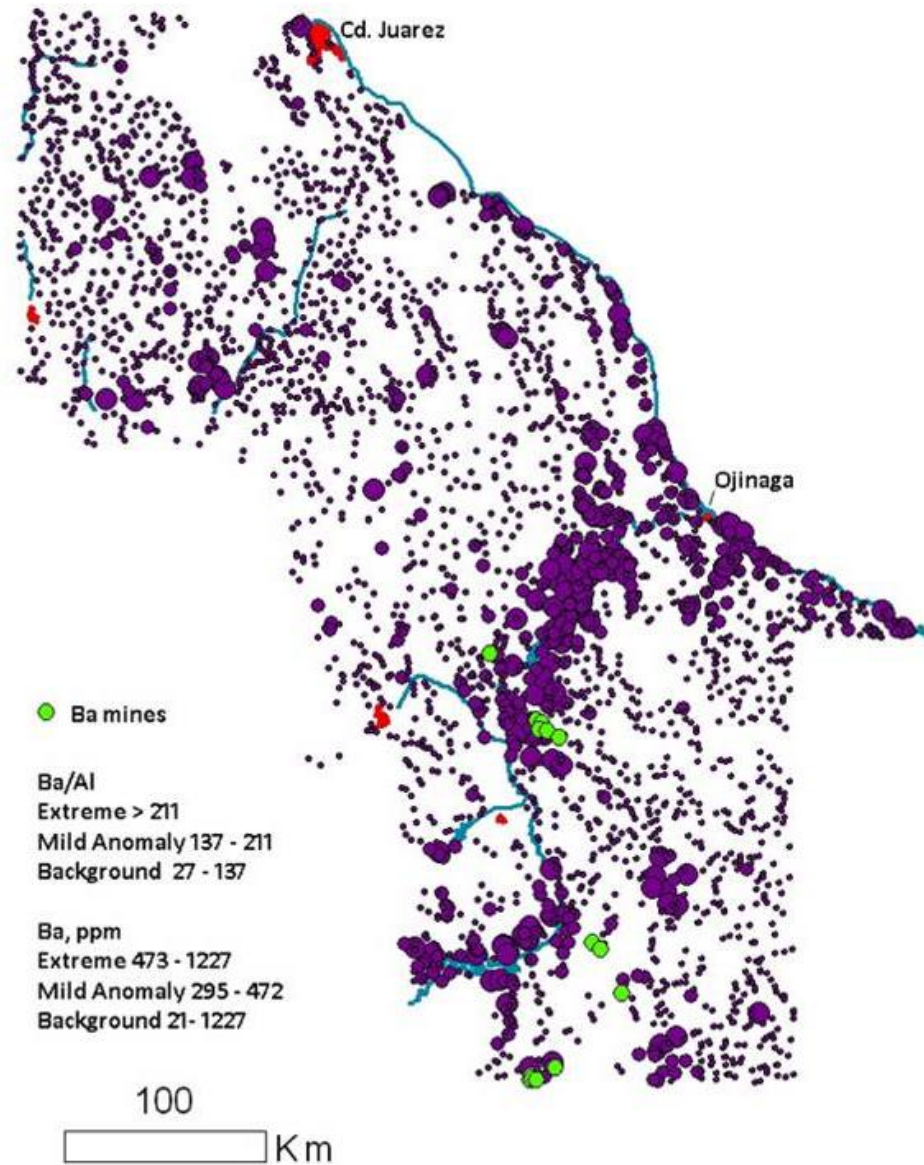
Being Reactivated:

Santa Rita, Cu, Zn, Pb

Georgina, Fe, Zn

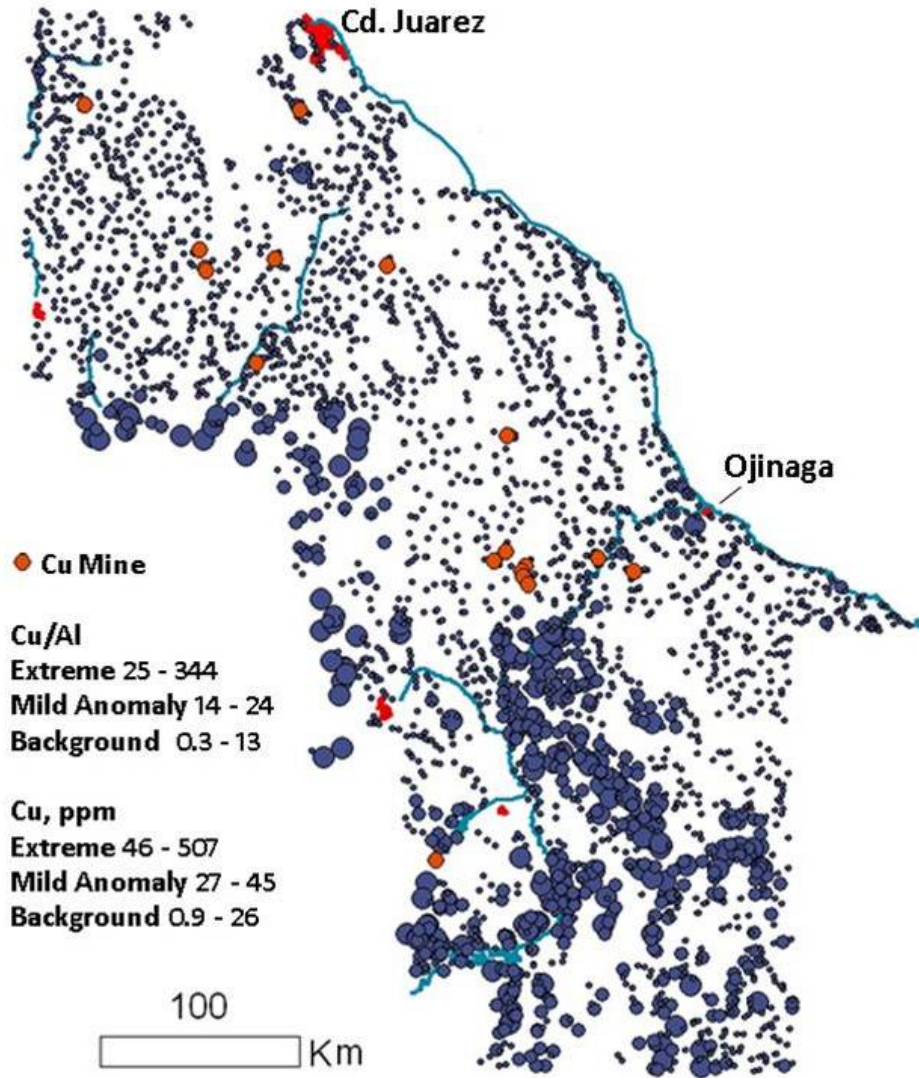


Ba/Al association with Ba mines



**Anomalies around
mines & mineral
deposits; the
dispersion pattern
follows streams,
indicating soluble
Ba**

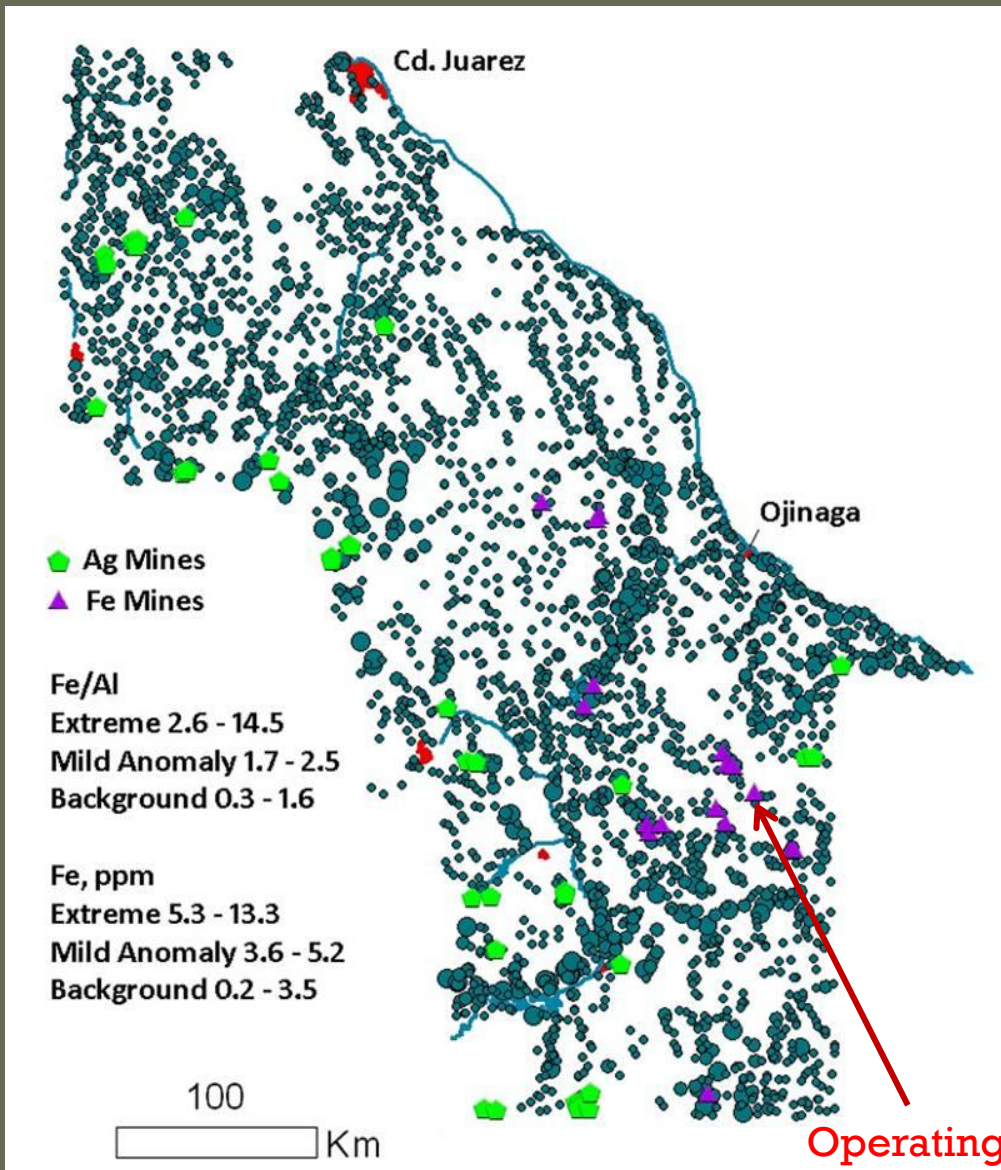
Cu/Al associated with Cu mines

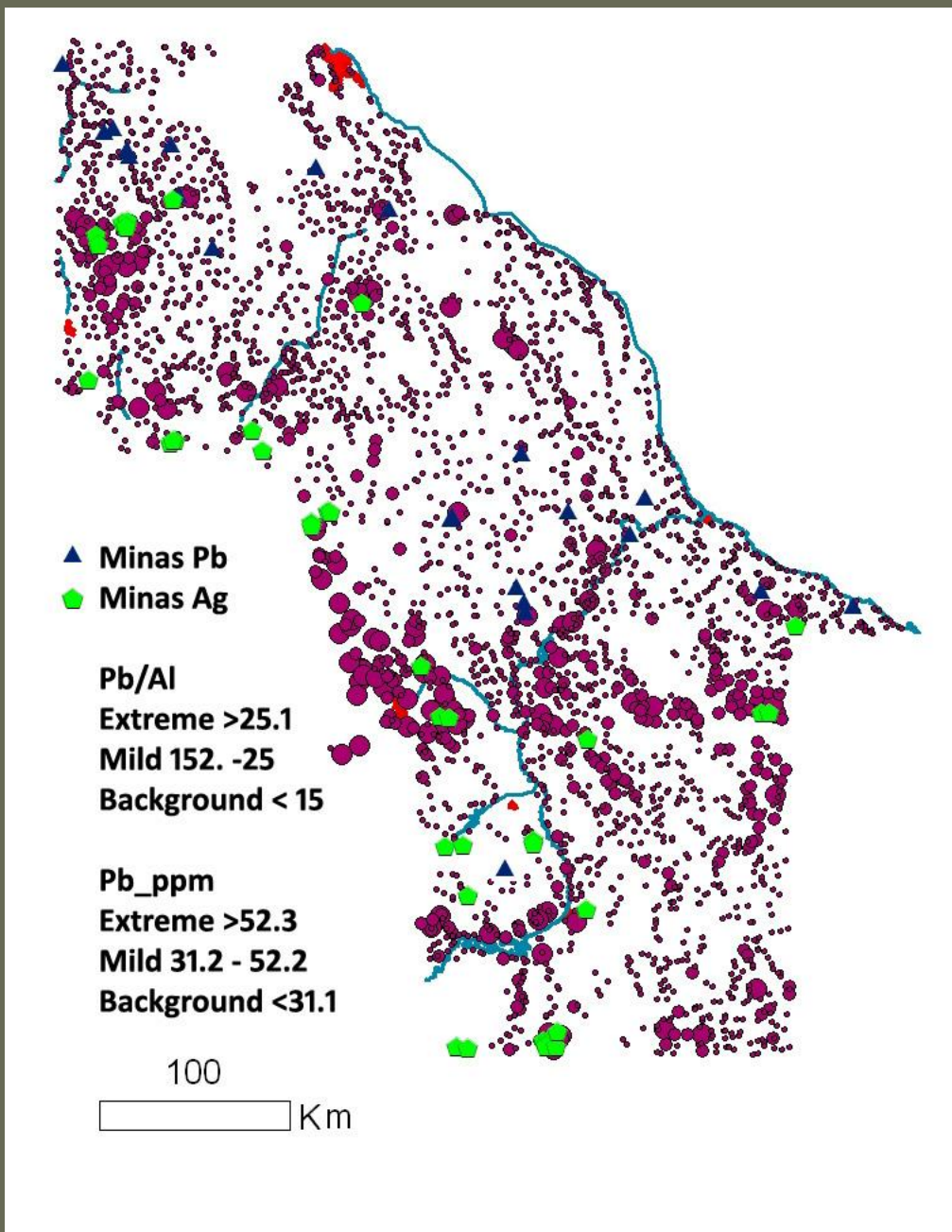


The anomalies do not cluster near Cu mines/deposits; dispersion is contained

Fe/Al associated with Fe mines

Anomalies cluster around mineral deposits (Pb, Ag, Fe), and show little dispersion





**Pb/AI
association with
Pb (& related)
mines**

**Anomalies cluster
around mineral
deposits (Pb, Ag,
Fe) and show no
dispersion**

Next

Identify and determine contribution from rock outcrops

Besides geochemistry, the data set (SGM, 2001) contains several superimposed GIS layers, among them there a geologic map, a convenient feature to identify the rock that outcrops directly above each anomaly.

Conclusions

- EDA analysis facilitated detecting the thresholds for background concentration, and mild and extreme anomaly values.
- Anomalies determined after EDA and normalization (AI) were able to pinpoint locations of geochemical significance (source) and showed their spatial dispersion pattern.
- Mining/prospecting is the most important source for most target elements, followed by geology.

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- Fe and Mn were the only target elements to show significant correlation ($R^2 > 0.6$).
- Anomalies plotted near mines/mineral deposits for Ba and Pb; Mn and Fe to a lesser degree ; while Cu did not follow this pattern at all.
- Dispersion patterns were Ba >> Fe > Cu, Pb

Thank you !