

Exploration of the Relationship between Information Content and Signal-to-Noise Ratio and Spatial Resolution

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OVERVIEW

- Objective
- Approach
- Algorithm
- Test Results
- Results for other environments
- Summary and Conclusion

OBJECTIVE

- Explore the relationship between signal-to-noise ratio, spatial resolution, and information content for AVIRIS spectral image data.
- Why? Formalize the requirement for high SNR
- The idea grew from talk at last years workshop comparing 20 and 2 meter AVIRIS data at Cuprite, NV.

Approach

- Look at information content of baseline SNR AVIRIS spectral image data.
- Increase SNR by averaging.
 - A 2 by 2 average increases the SNR by 2
- Ungeorectified low altitude data from a range of environments were analyzed.
- QUESTION: How does the information content change as the SNR increases and the spatial resolution decreased?

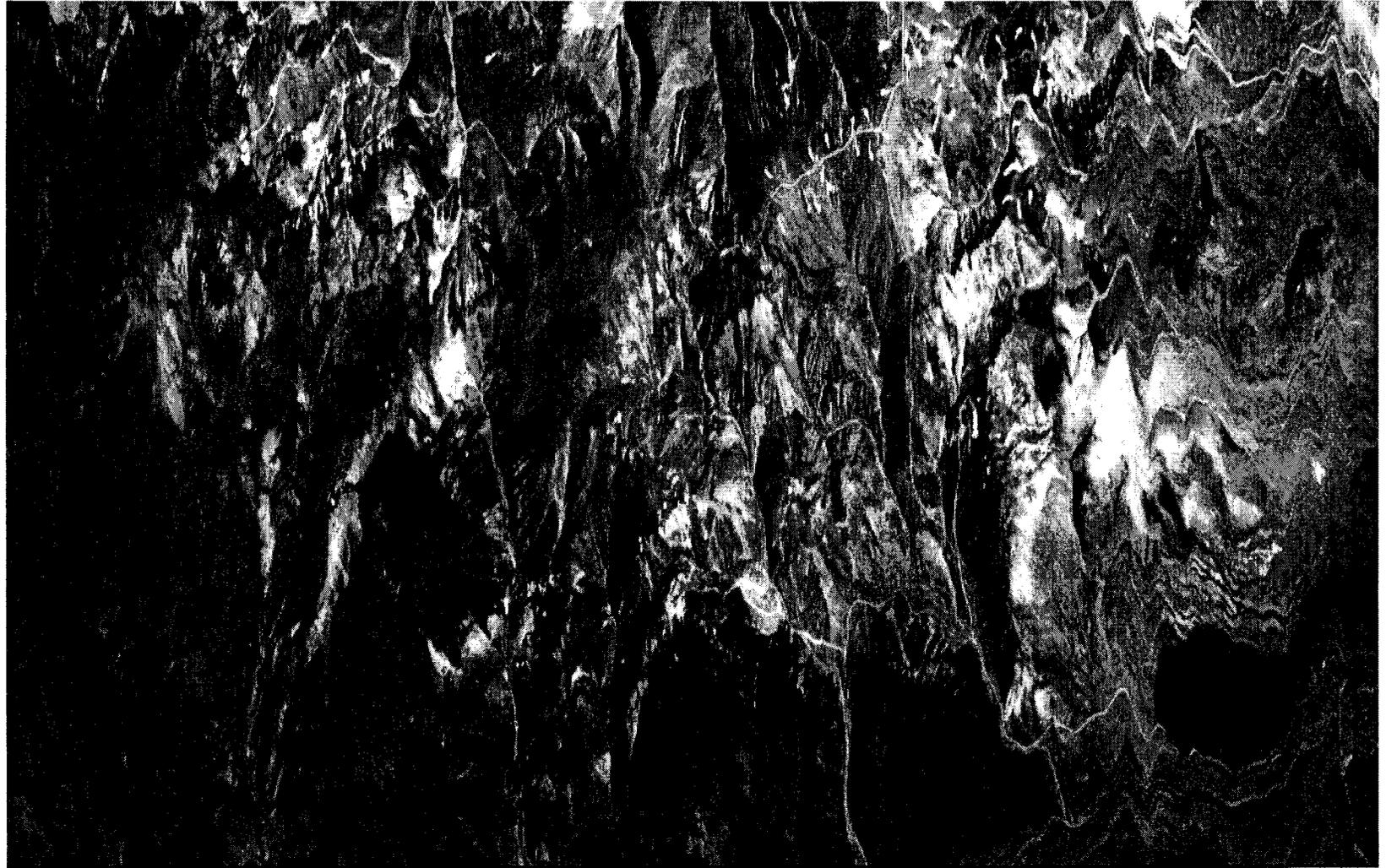
Algorithm

- The MNF transform was chosen as a self consistent estimator of information content
- The MNF transform assess and normalizes variance due to noise and then rotates the data to orthogonal vectors of decreasing variance.
- The eigen values and the MNF image may be used to assess the information in the MNF rotated data

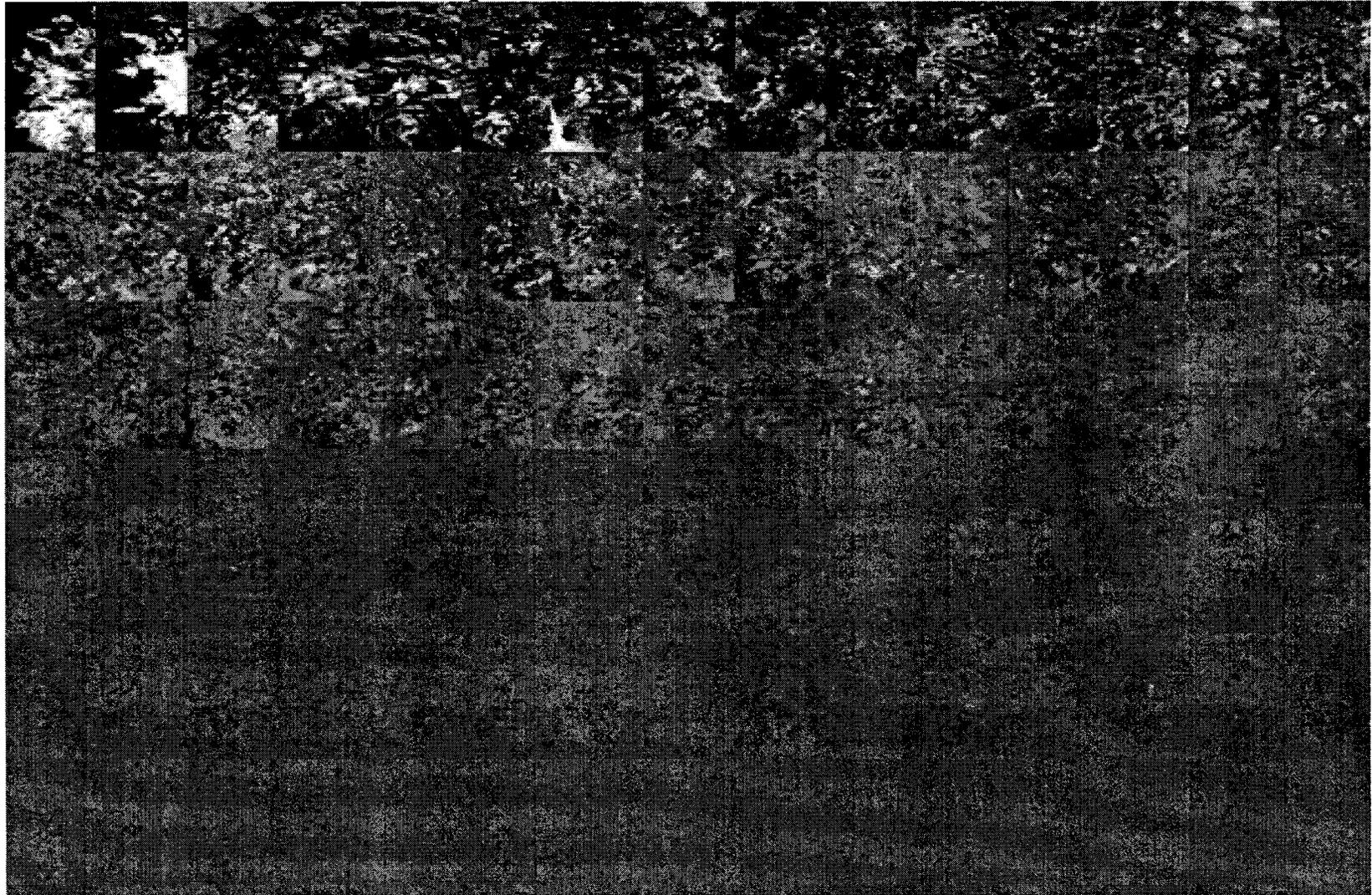
Test Results

- The first AVIRIS data set examined was Cuprite, NV
- The MNF was run on a 1000,614,224 line, sample, channel radiance image
- The images was then averaged by 2, 4, 8 with an MNF run on each
- Two criteria for information in the MNF were used
 - Eigen value greater than 2
 - RGB image of MNF images showed plausible spatial content

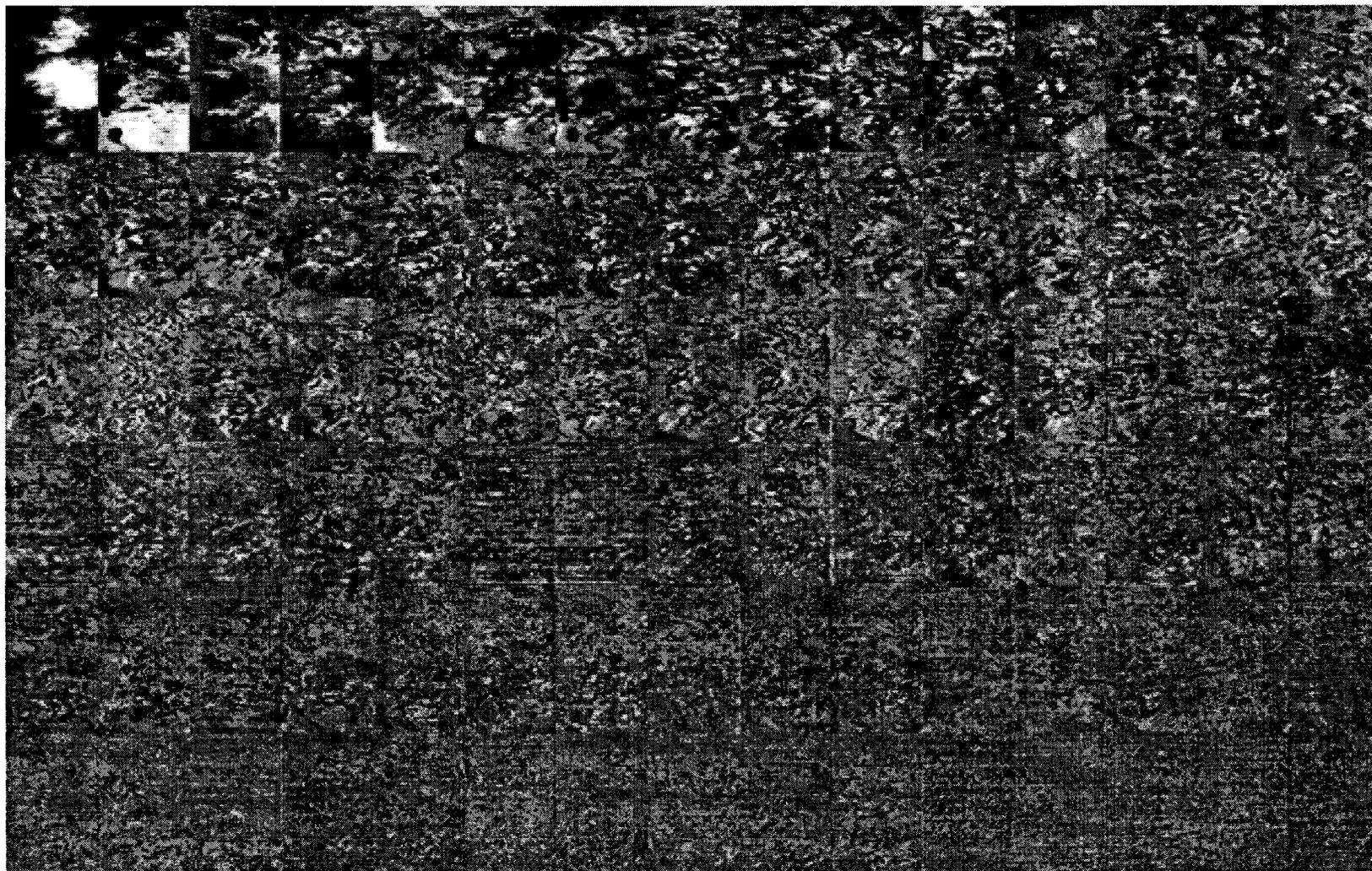
AVIRISLA Cuprite, NV RGB



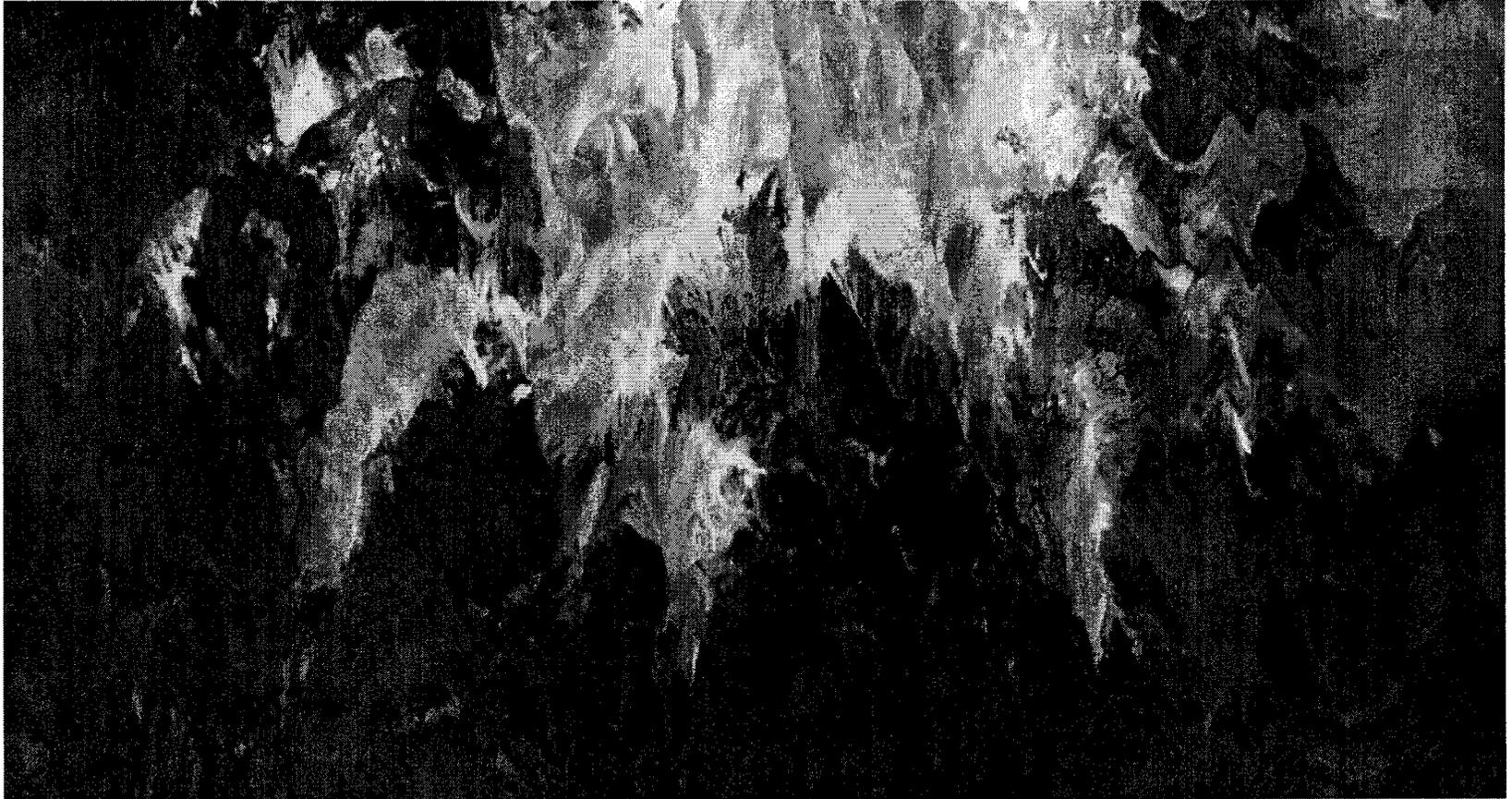
Cuprite, NV 1XMNF



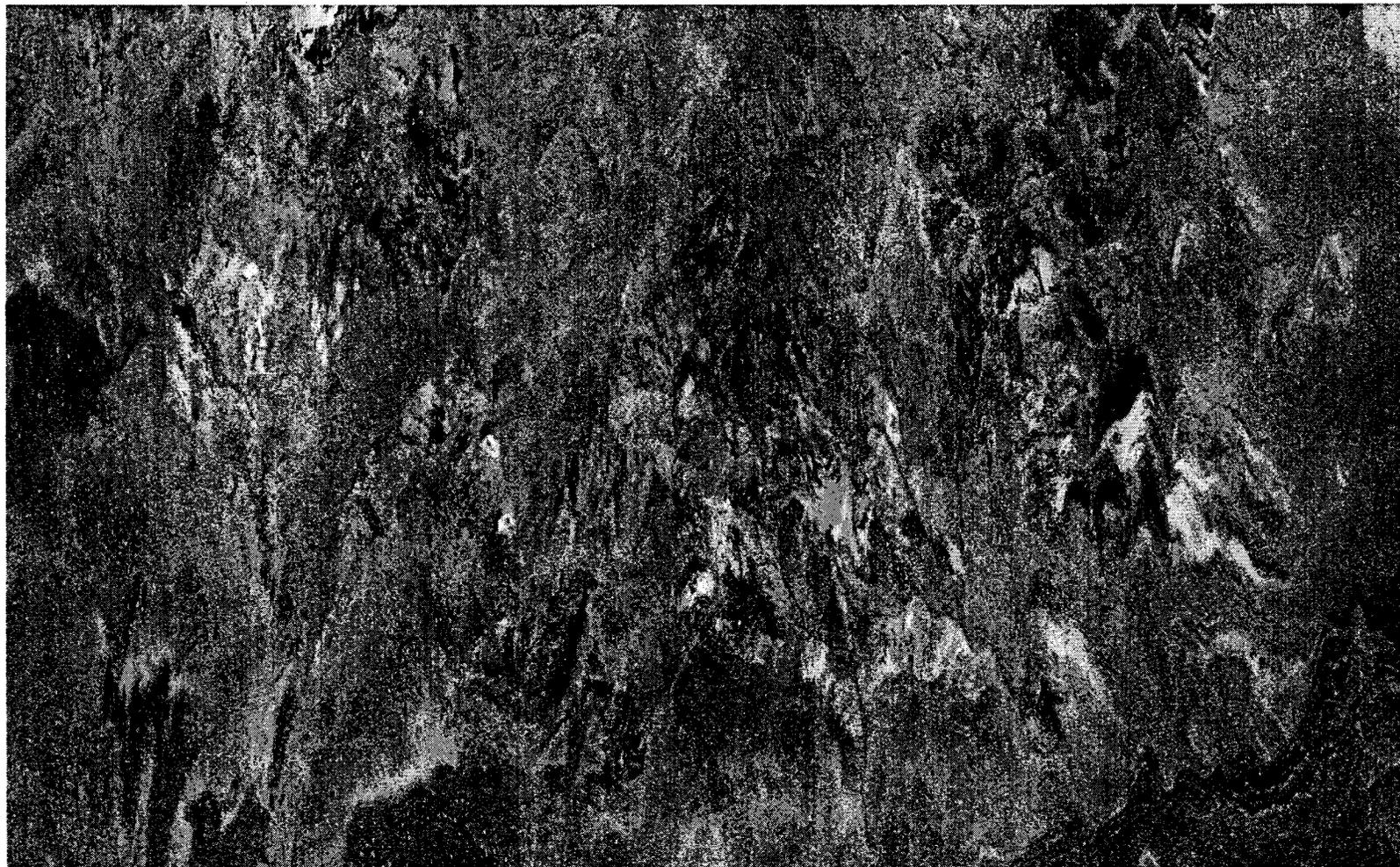
Cuprite, NV 4XMNF



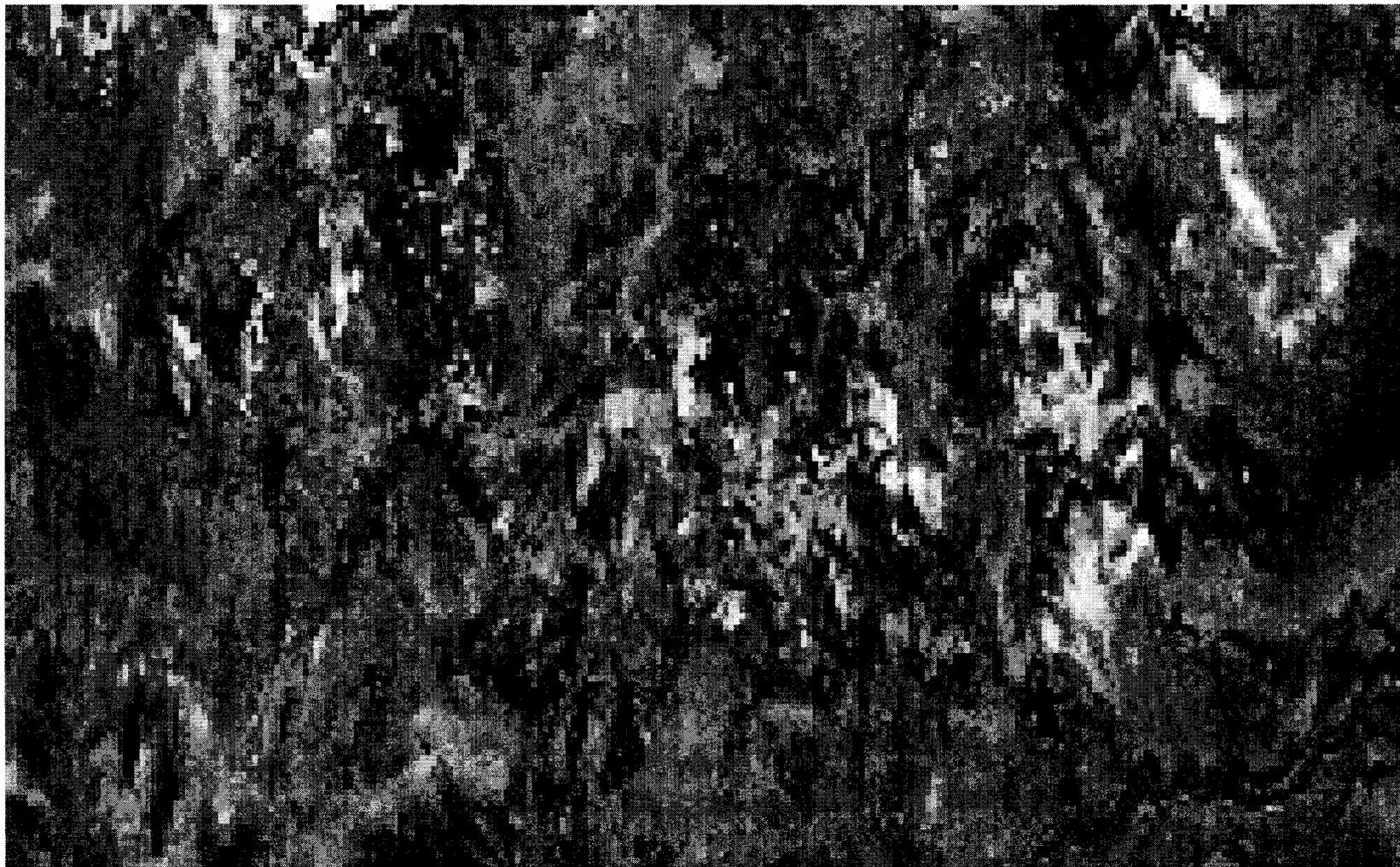
OVERVIEW



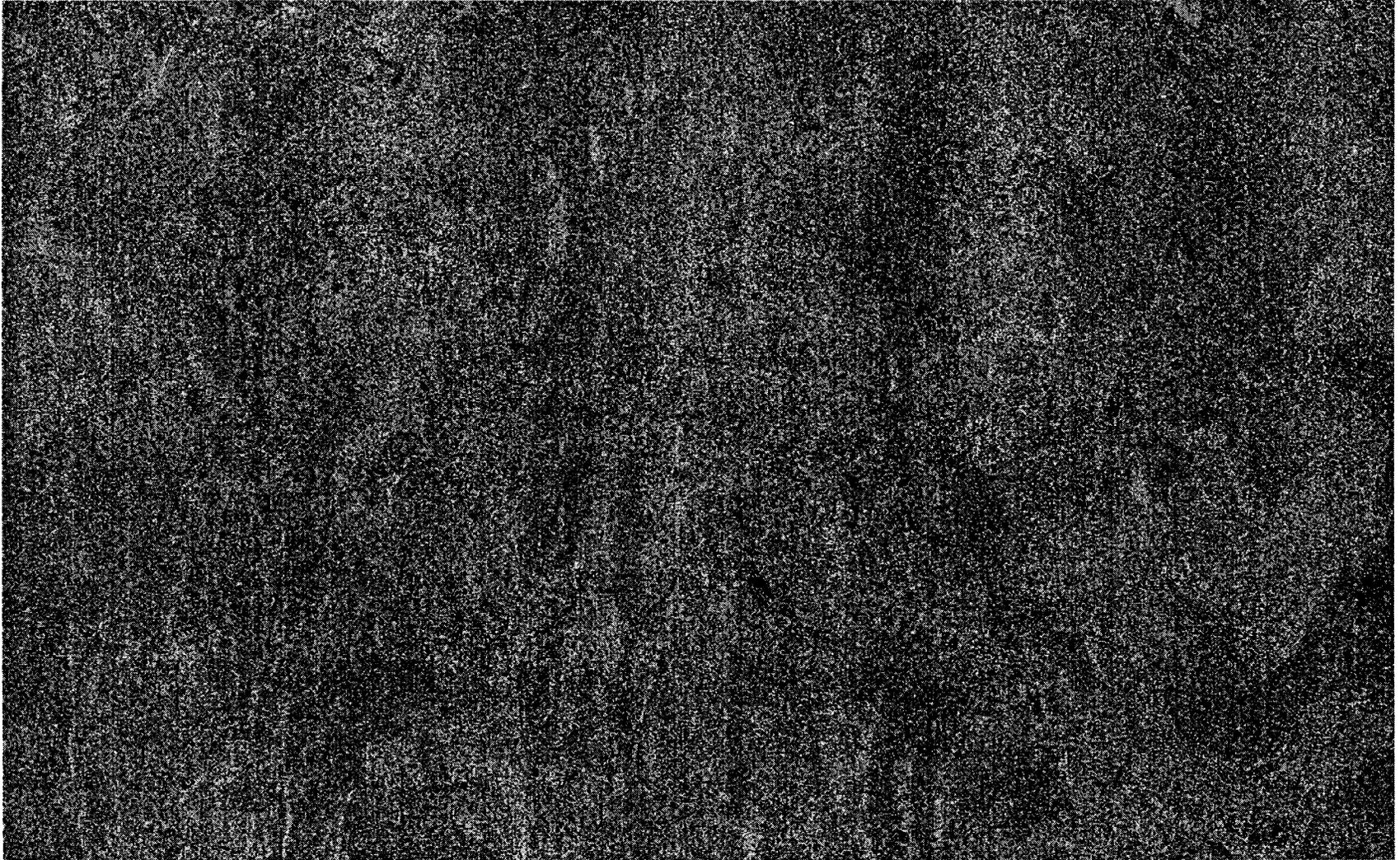
Cuprite, NV: MNF 1X: 21,22,23



Cuprite, NV: MNF 4X: 21,22,23



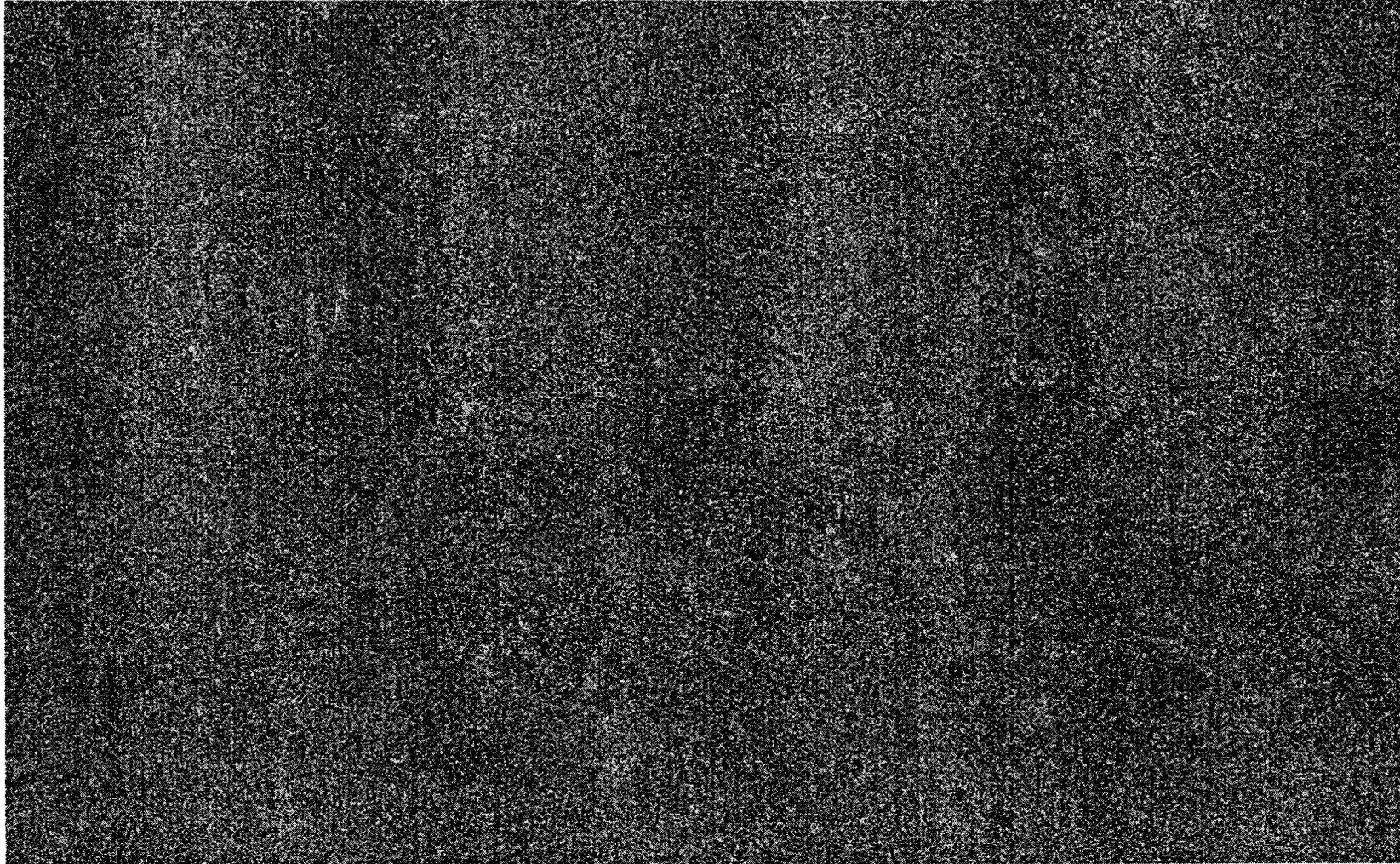
Cuprite, NV: MNF 1X: 41,42,43



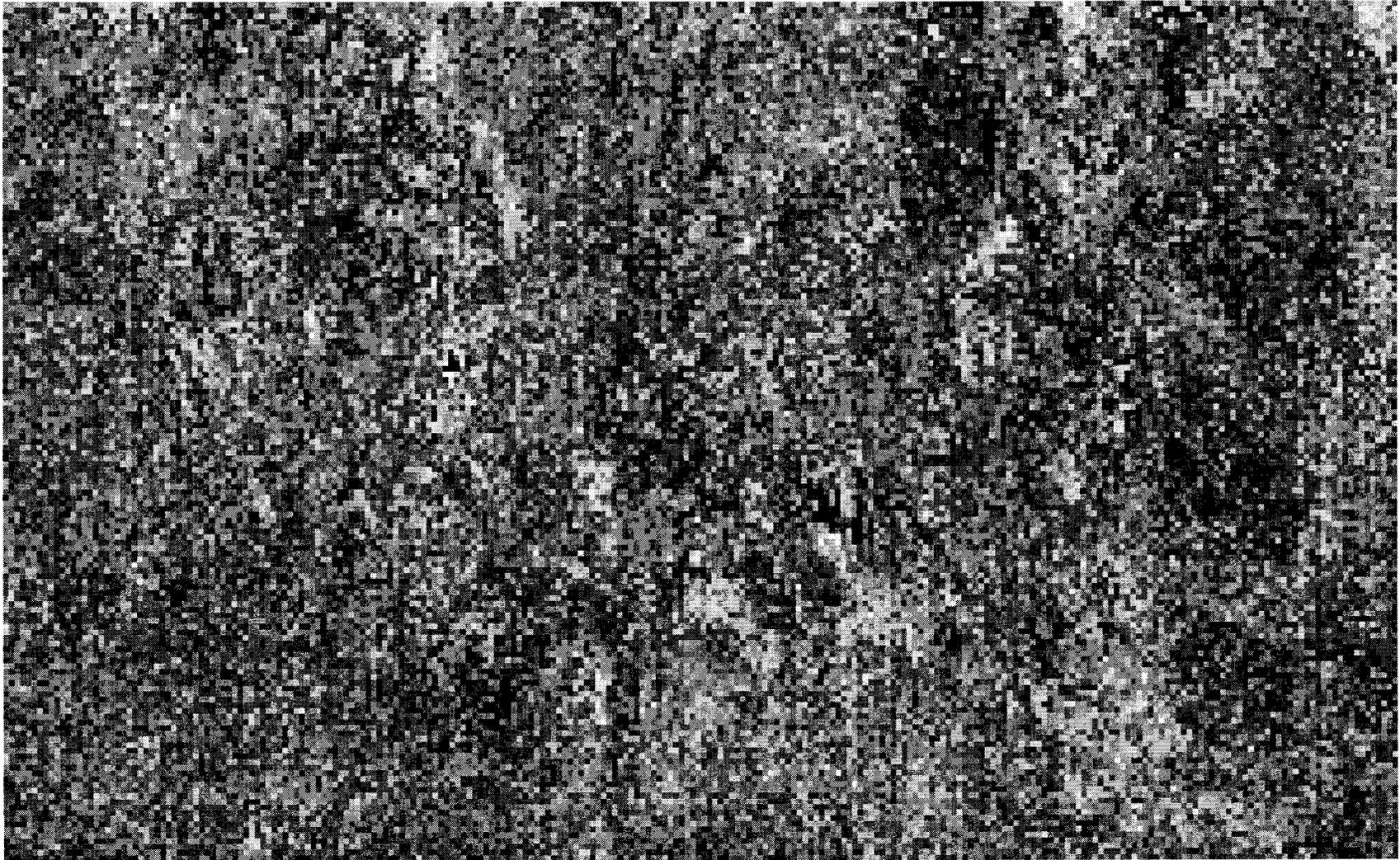
Cuprite, NV: MNF 4X: 41,42,43



Cuprite, NV: MNF 1X: 61,62,63

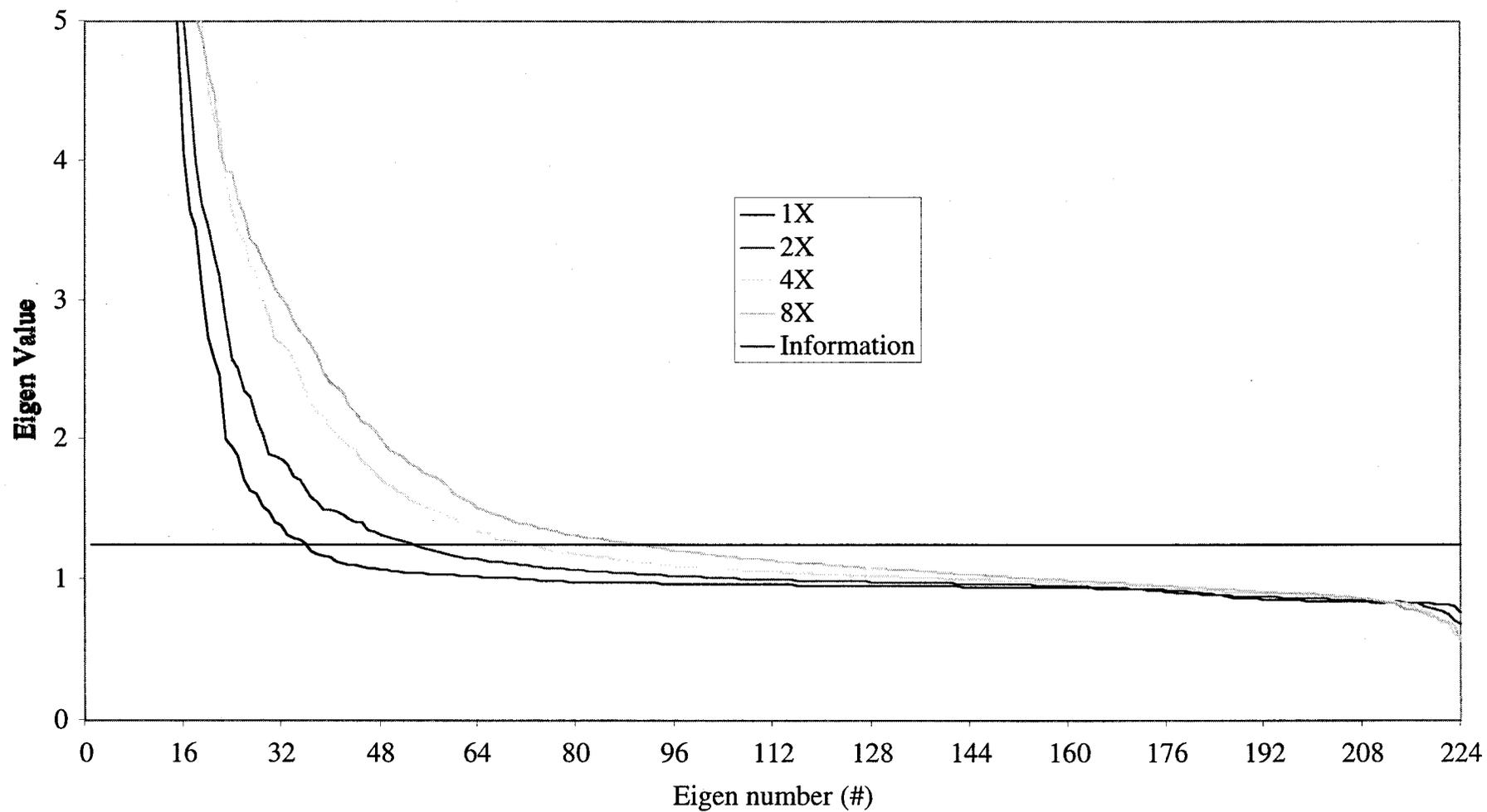


Cuprite, NV: MNF 4X: 61,62,63



Eigen Value Results

AVIRIS Cuprite, NV MNF Analysis



Results for Other Environments

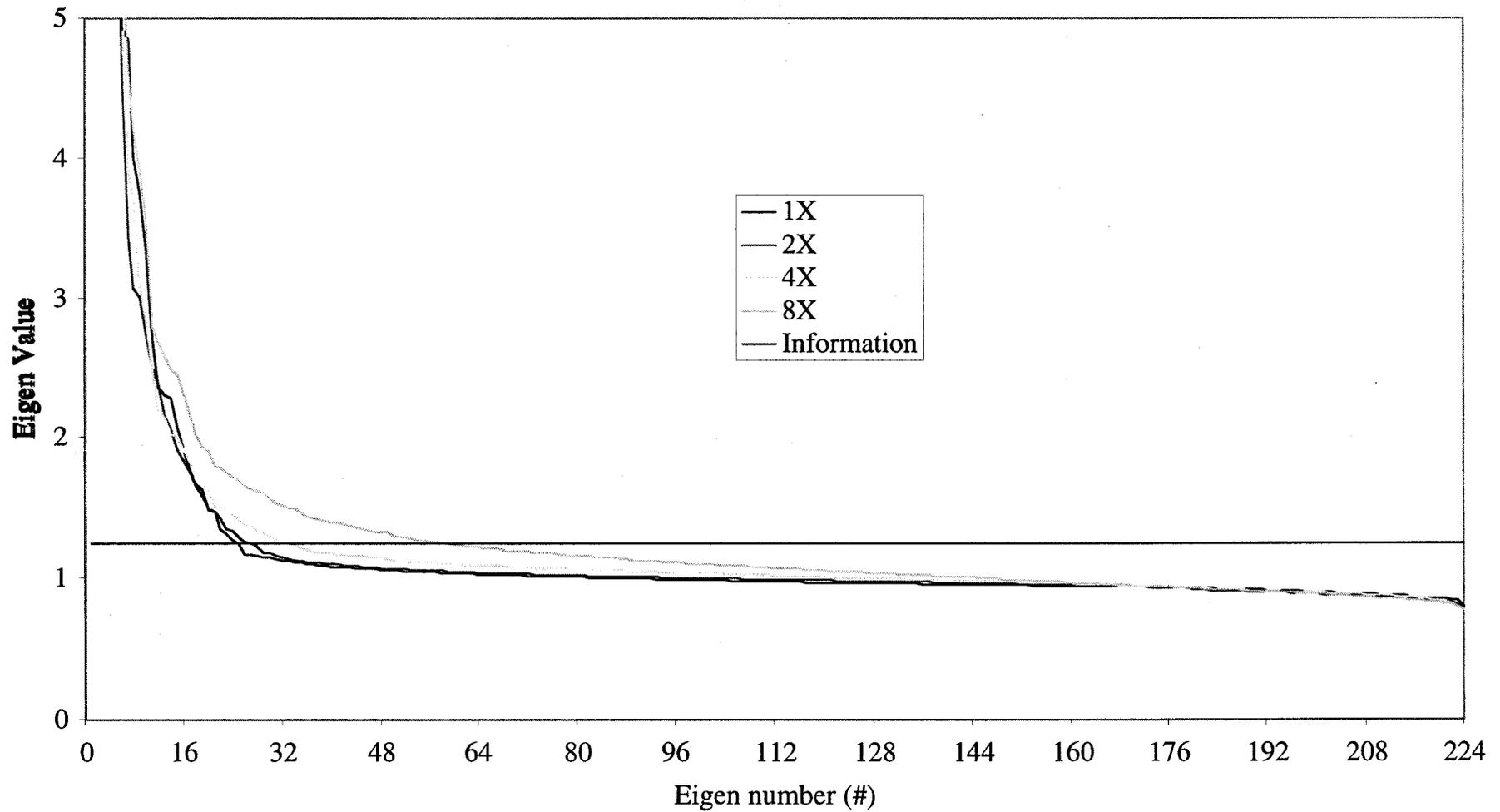
- Forest Vegetation
- Urban
- Coastal
- Chapparal

CONGAREE NATIONAL SWAMP (A)



Eigen Value Results

AVIRIS Congaree National Swamp, VA MNF Analysis

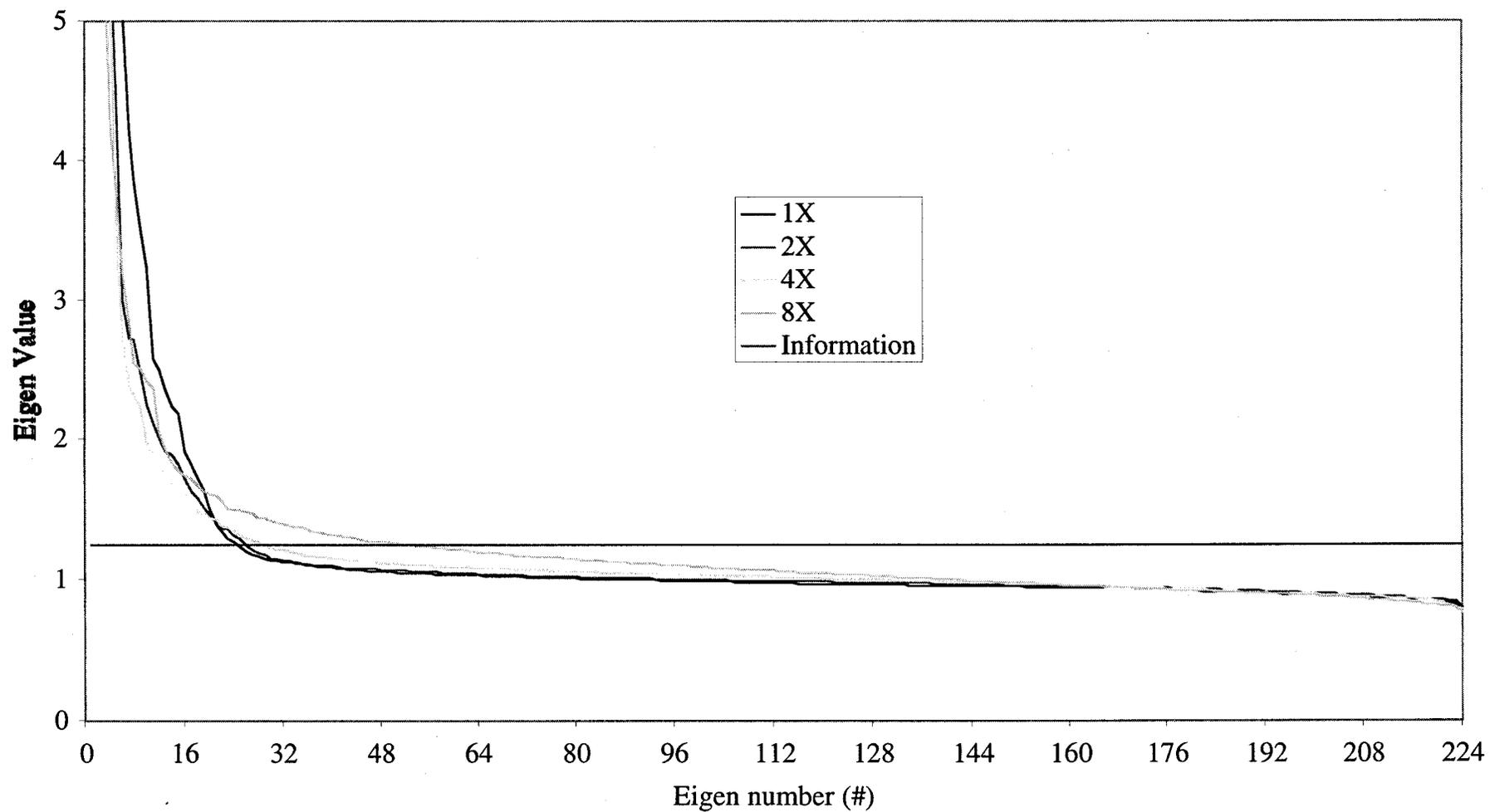


CONGAREE NATIONAL SWAMP (B)



Eigen Value Results

AVIRIS Congaree National Swamp (B) MNF Analysis

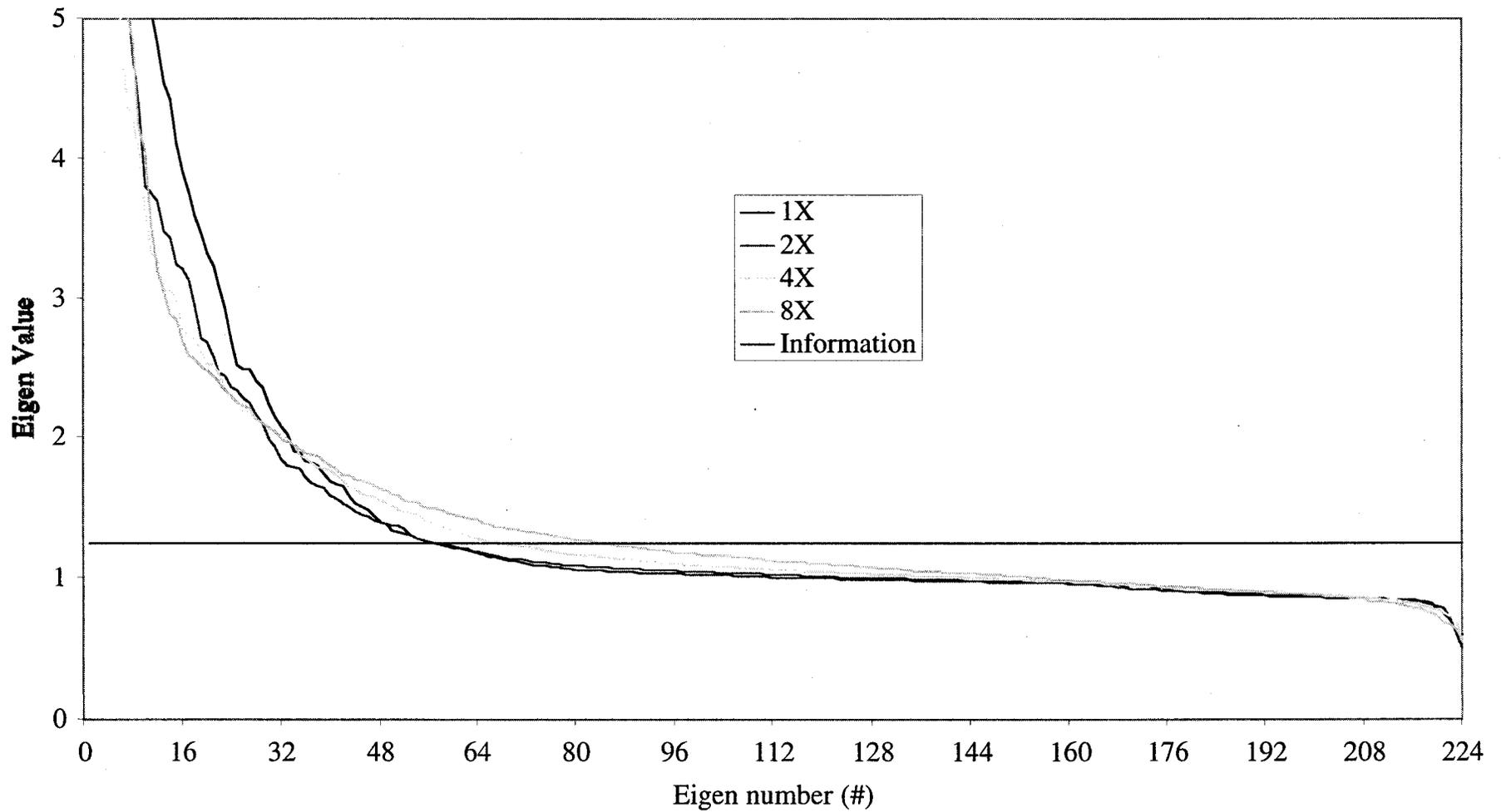


San Diego, CA

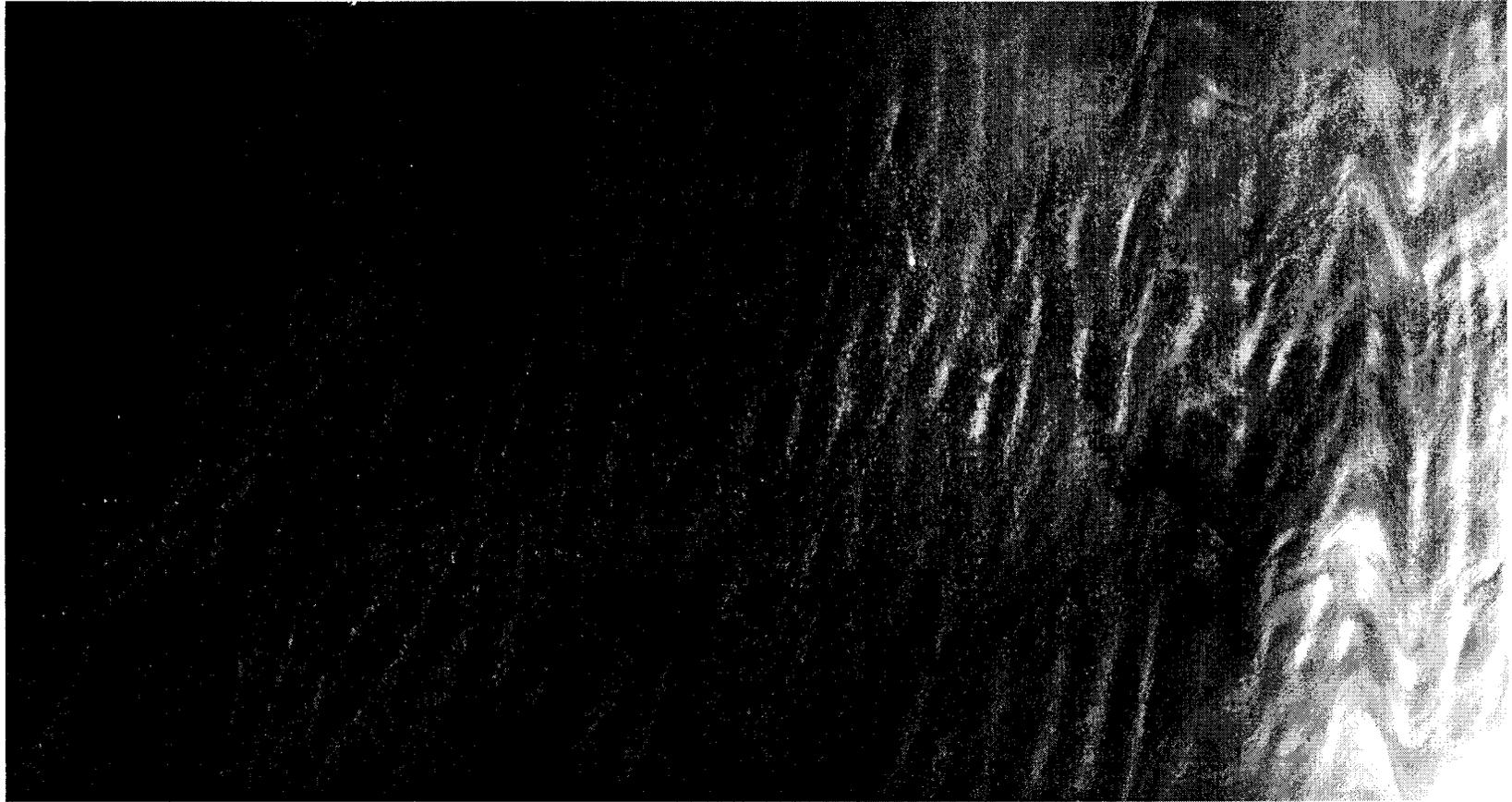


Eigen Value Results

AVIRIS San Diego, CA MNF Analysis

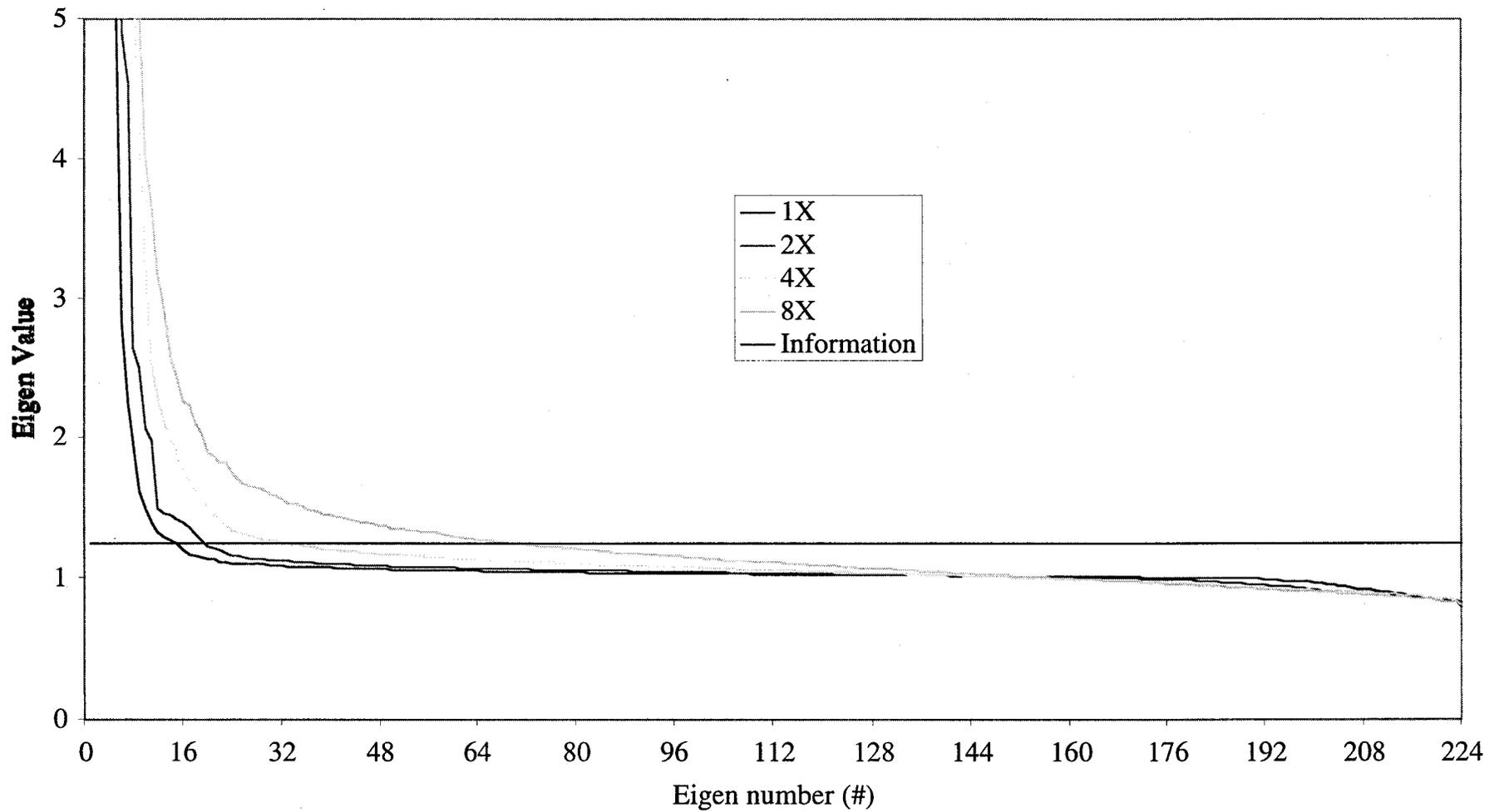


OVERVIEW

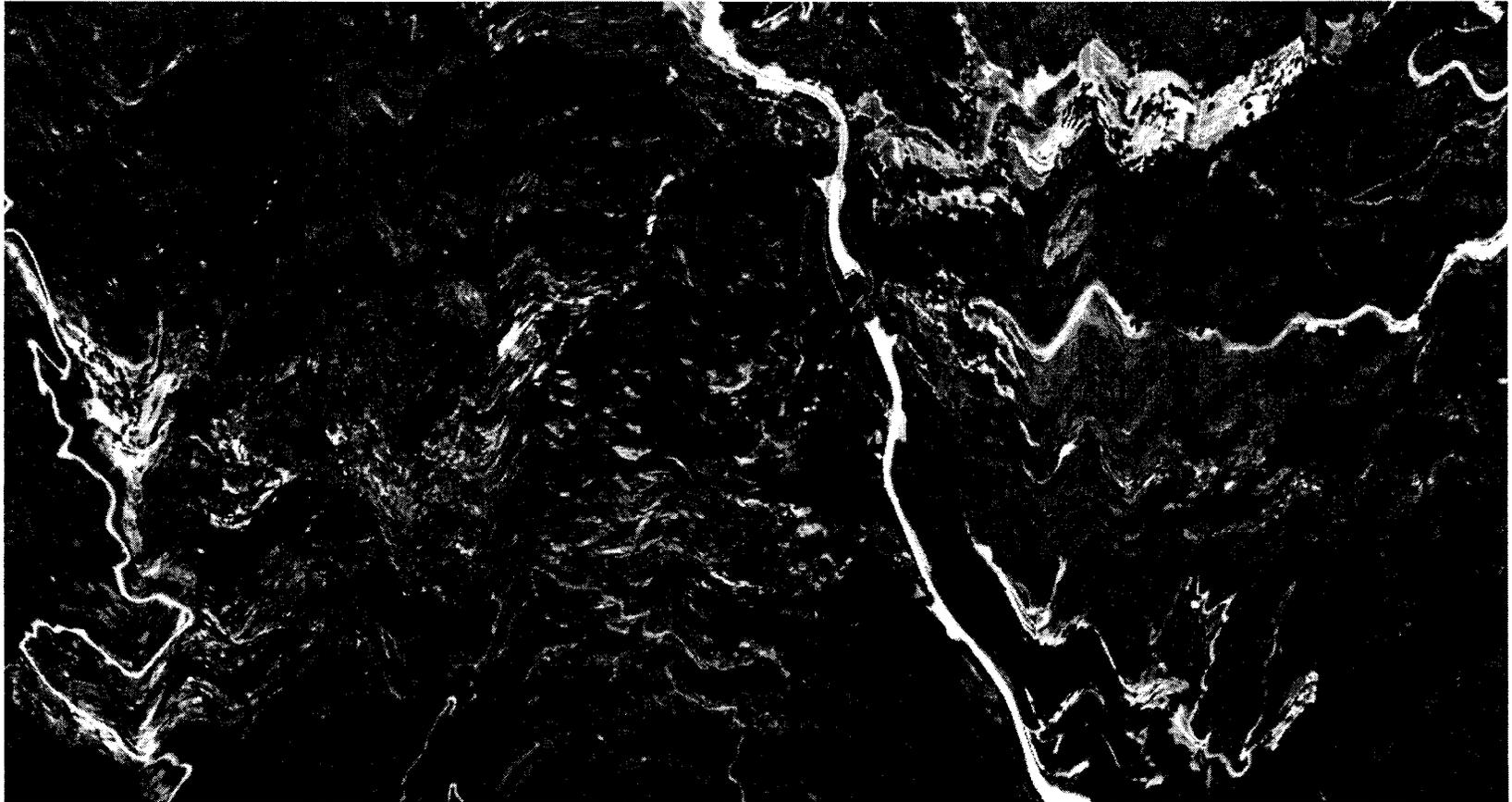


Eigen Value Results

AVIRIS Coast of San Diego, CA MNF Analysis

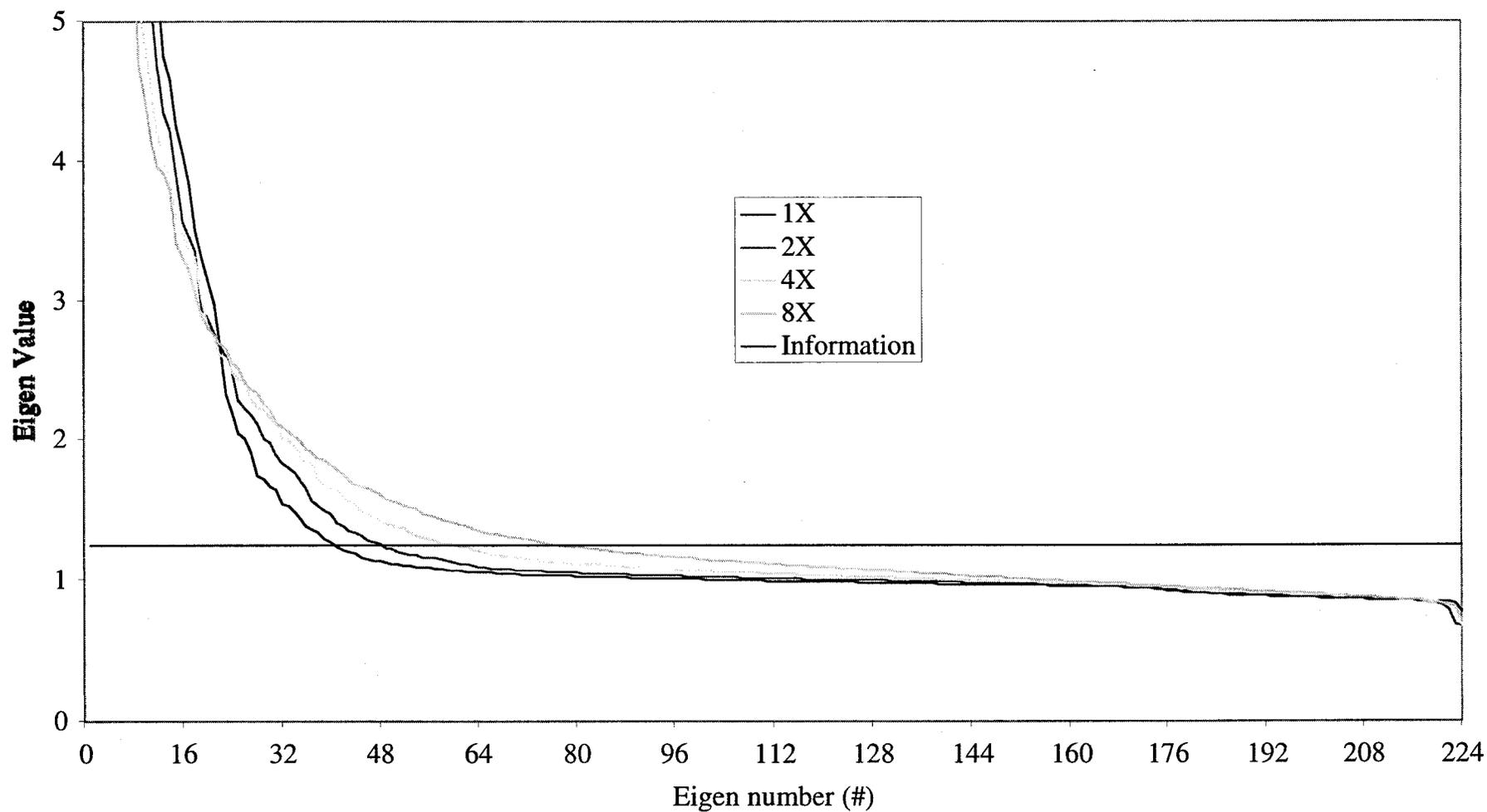


OVERVIEW



Eigen Value Results

AVIRIS Santa Monica Mountains, CA MNF Analysis



Summary and Conclusions

- Overall, the information content rises with SNR through averaging even with the loss of spatial resolution
- The trade between SNR and spatial resolution varies with environment. The best improvement comes with patchiness at scales greater than the largest averaged spatial resolution.
- High signal-to-noise ratio is essential to take advantage of the full spectrum coverage of an imaging spectrometer

Questions