



# APPLICATION OF THE VREE LAND SPECTROSCOPE FOR RAPID ANALYSIS OF STONY METEORITES

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The Journal of the Meteoritical Society  
Plain view, TX

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In the field of meteorite research, there is a need for a rapid, yet accurate method for bulk chemical analysis. This is especially true for areas in which there is a large abundance of meteorites. For example, the numerous stony meteorites in the area around the city of Plainview, Texas. Although most finds from this area are related to the same fall, others such as Hale Center No. 1 and No. 2 and Plainview 1950 have proven to be unrelated. The chances are good that there may also be additional finds within the original strewnfield which are also unrelated to the aforementioned. If either wet chemical or electron microprobe analyses are to be used on every Plainview find, it will be both time consuming and costly. Hence the need for a rapid, economical, and yet accurate procedure for determining the identity of additional discoveries.

In this study, the Vreeland spectroscope was employed for both qualitative and quantitative analyses. In the Vreeland, a carbon arc excites the specimen being analyzed. The light is then passed through a diffraction grating. The spectrum of the specimen can be read directly with the aid of reference films which are located on either side of the observed emission pattern. Since the emission lines and the reference films are displayed against a continuous spectrum background, they are seen in their true colors which helps in the identification of key lines in the pattern and which elements are generating these lines. The instrument is also equipped with an angstrom scale which further aids in identification.

Data were obtained using the Vreeland for the Lazbuddie, Brownfield, and Plainview meteorites for the elements Fe, Ni, Cr, Ca, Mg, and Na. These were compared to data obtained using standard wet chemical techniques in order to determine the accuracy.

Table 1  
Wet chemistry vs. Vreeland: A comparison of mean values

| Meteorite  | Element | Wet   | Vreeland |
|------------|---------|-------|----------|
| Lazbuddie  | Fe      | 24.1  | 24.19    |
|            | Ni      | 1.22  | 1.43     |
|            | Cr      | *     | 0.44     |
|            | Ca      | 0.66  | 0.64     |
|            | Mg      | 15.84 | 13.98    |
|            | Na      | *     | 0.75     |
| Brownfield | Fe      | 26.16 | 25.14    |
|            | Ni      | 1.2   | 1.43     |

|           |    |       |       |
|-----------|----|-------|-------|
| Plainview | Cr | *     | 0.37  |
|           | Ca | 1.6   | 0.9   |
|           | Mg | 15.6  | 13.05 |
|           | Na | *     | 0.76  |
|           | Fe | 27.32 | 26.22 |
|           | Ni | 1.39  | 1.46  |
|           | Cr | *     | 0.43  |
|           | Ca | 0.91  | 0.93  |
|           | Mg | 14.94 | 14.77 |
|           | Na | *     | 0.77  |

\*No comparison could be made because the wet analysis was inconclusive.

When used for quantitative analyses, the Vreeland is fitted with the Quantrex attachment. The Quantrex is a modified Polaroid camera and is fitted with a split-prism viewer so that the spectrum can be viewed while the photograph is being made.

In the Quantrex, the spectrum is projected to a cylindrical mirror which elongates the spectral lines across the full length of the film. A neutral density filter with logarithmically increasing opacity is placed between the mirror and the film. This causes the spectral lines on the photograph to be tapered. The length of the resulting lines are proportional to their intensities and thus to the concentration of the elements causing them.

Once the spectrum has been photographed, the length of the spectral lines are marked on the photograph. The length of the line is taken to be that point where it can not be distinguished from the background. However, the most important thing in determining the line length is to be consistent. The line intensity is read off the scale at the bottom of the photograph.

A set of at least three independent standards is required for each element to be analyzed. The percentage of the element present in the standard must be close to the percentage present in the sample. A value within 15-20% of the latter will give satisfactory results if the element is relatively abundant in the sample. For trace elements, a range of 5-10% is advisable. If there is a wide variation in the percentage of the element present, more than one set of standards may be required. For example, the determination of iron in iron and stony meteorites requires two sets of standards one for the irons and another for the stony meteorites. The matrix of the standard should be as similar as possible to the matrix of the specimen being analyzed. This eliminates error caused by a difference in burning rates. For the analysis of stony meteorites, cutting the standards with pure quartz powder corrects this problem. Using a variety of substances for standards and using ceramic hearths instead of carbon cups also gives more even and reliable burning rates. The use of hearths also prevents excessive loss of samples by spattering.

Once the standards are prepared, their spectra are photographed and the intensity of the spectral lines is plotted against the percentage of the element present. The resulting curve is logarithmic and becomes the standard curve for that element. After the standard curves are made, the spectra of the meteorites can be photographed and the percentage of the elements being sought extrapolated from the graph of the standard curve.

The results of this study were as indicated in Table 1 . No comparisons could be made for Cr and Na because the wet chemical analyses were inconclusive due to interference of sulfate in the

analysis of Cr and co-precipitation of uranium complexes in the analysis of Na. Neither of these problems could be eliminated at the time.

The Vreeland technique was found to have the following advantages:

1. Very small samples are all that were needed. The average sample size used in this study was 100 mg. Samples as small as a few micrograms could have been used, but the larger samples are more representative.
2. Very small element concentrations were detected. However, the standards had to be prepared accordingly. When this was done, concentrations as small as a few ppm could be detected without a significant loss of accuracy.
3. There was a great savings in time. It took twenty man hours to do a wet analysis on nine samples and twelve to do the same number of samples on the Vreeland, including the preparation of the standards. This time may vary, depending upon the sample being analyzed. Since all three meteorites used in this study were stony with similar matrices, they were analyzed very rapidly once the standard curves were made.

In summary, this study has found the Vreeland to be useful for pilot studies for Fe, Ni, Cr, Ca, Mg and Na in stony meteorites. Such a study can help determine whether further analyses such as microprobe are warranted. Further study is being undertaken to determine the limitations of the Vreeland when used in this type of work and in developing methods to overcome these limitations.