Textural Mineral Mapping of the Farmville Meteorite using GIS Software. S.A. Singerling[1], A.F. Glazner[2], S.J. Singletary[3], T.M. Pavelsky[4], and R.C. Tacker[5], [1]University of North Carolina at Chapel Hill, Chapel Hill, NC 27599, singerli@email.unc.edu, [2]University of North Carolina at Chapel Hill, Chapel Hill, NC 27599, afg@unc.edu, [3]Fayetteville State University, Fayetteville, NC 28301, ssingletary@uncfsu.edu, [4]University of North Carolina at Chapel Hill, Chapel Hill, NC 27599, pavelsky@unc.edu, [5]North Carolina Museum of Natural Sciences, Raleigh, NC 27601, Christopher.Tacker@ncmail.net.

Introduction: Chondritic meteorites represent the oldest and most primitive material in the solar system [1]. Chondrites are a kind of stony meteorite characterized by the presence of chondrules, spherical granules of debatable origin. The ordinary chondrites are the most abundant class of chondrites, being further divided into the H, L, and LL classes which signify high total Fe content, low total Fe content, and low metallic Fe content, respectively[1]. Following the classification scheme of Van Schmus and Wood, the nature and degree of secondary alteration of the meteorite is represented by a number [2]. Thermal metamorphism, common in ordinary chondrites, is designated as 3 to 6 with an increase in number corresponding to an increase in metamorphism [1].

The Farmville meteorite received a classification as an H4 ordinary chondrite in the 1930s while housed at the North Carolina Museum of Natural Sciences, but the source of this classification is not documented [3]. The overall purpose of this project is to determine if Farmville was properly classified, to examine the size, spatial, and textural distribution of chondrules, and to test the use of GIS software for mapping mineral phases. The latter of the three overall goals is the focus of this presentation.

This aspect involves ENVI (Environment for Visualizing Images) software, commonly used for remote-sensing purposes. ENVI is a digital image processing graphical user interface that performs multispectral data analysis of satellite images [4]. In this research, ENVI is used to classify mineral phases based on data obtained from SEM X-ray images. With the resulting images, we analyze textural maps for phase distributions in the meteorite as a whole and in chondrules as well.

Methods: We analyzed samples of Farmville from the North Carolina Museum of Natural Sciences. We analyzed four thick sections, prepared with epoxy, and five thin sections, received from the Museum, in an SEM with a probe current of 1500pA. We created and probed backscattered images to determine the presence of common mineral phases (Figure 1). We also composed X-ray images (Figure 2) and blurred the images with a 1-pixel Gaussian blur in Adobe Photoshop to dampen speckling (Figure 3).

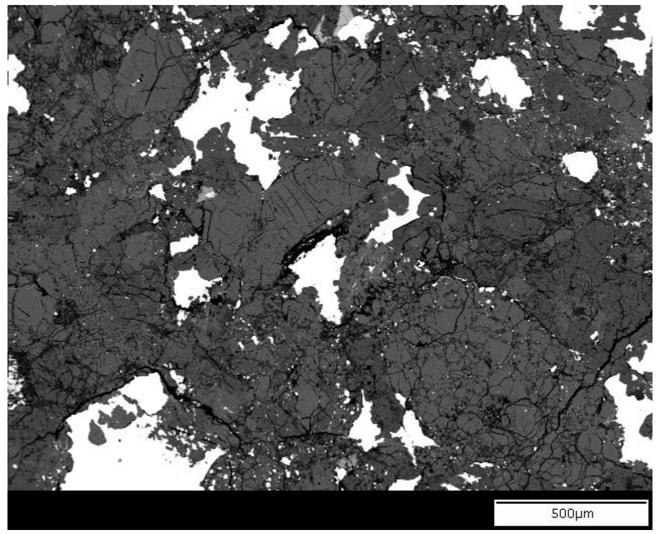

Figure 1. Backscattered electron image of Farmville thin section sample NCSM 2450. Different phases are visible but difficult to see clearly. Note that all the metal phases; troilite, taenite, and kamacite; appear white and are difficult to distinguish.

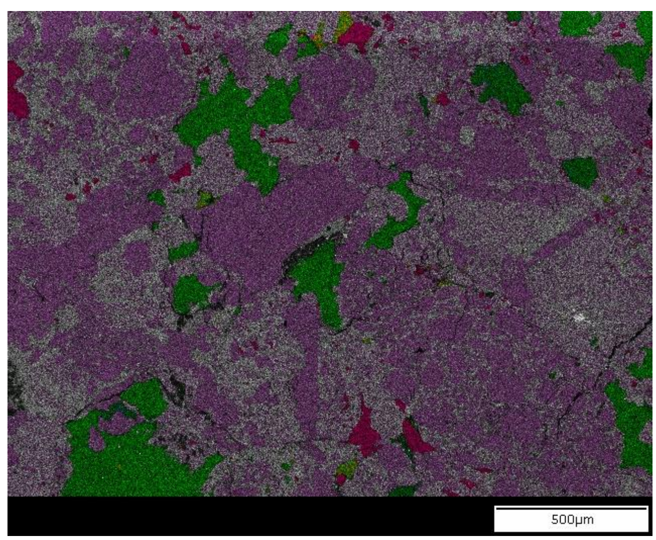

Figure 2. Phase map of an SEM X-ray image. The relative elemental abundances are apparent, but the actual phases are not. Such an image provides limited information. Many mineral phases share common elements which would make distinguishing them difficult in an X-ray image.

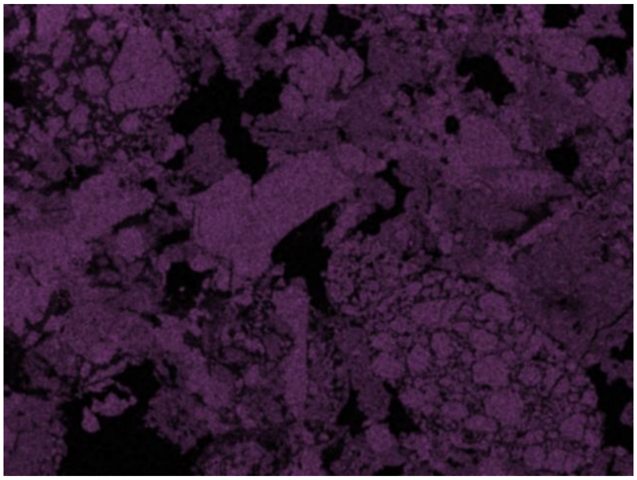

Figure 3. The Mg band from the X-ray phase map in Figure 2 blurred to 1 pixel.

We then treated the X-ray bands of the SEM images like Landsat hyperspectral bands using ENVI. The resulting image was false-colored and unclassified (Figure 4). That is, it gave no more data or insight than the X-ray images from the SEM. In order to obtain useful data not already available from the X-ray images alone, we selected different regions of interest. ENVI performed a supervised classification using SEM spot analyses to assign classification regions of interest. We performed a minimum distance classification with the final result being a textural mineral map of an SEM image (Figures 5 and 6).

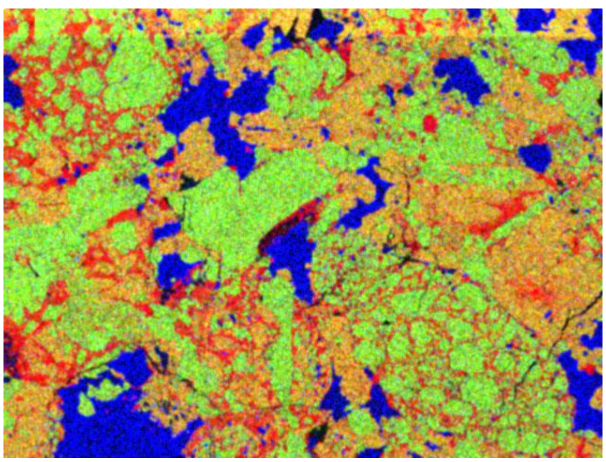

Figure 4. Unclassified image produced in ENVI as a result of layer stacking. We will define regions of interest on this image. Note how the different phases are more visible than in Figure 1.

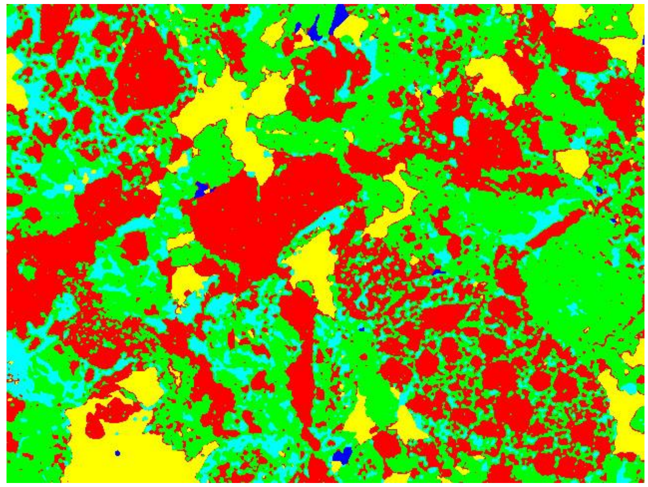

Figure 5. Classified image produced in ENVI with a minimum distance classification. The following colors correspond to the mineral phases listed: red = olivine, green = pyroxenes, light blue = plagioclase, dark blue = chloroapatite/other phosphates, and yellow = metals (kamacite,taenite,troilite).

Discussion: Textural mineral maps may provide information not easily visible in backscattered images, X-ray images, or transmitted-light thin section images. We can convert these maps into polygonal GIS files for quantitative textural analysis. For example, we can test if some phases have a tendency to form adjacent to certain other phases. We can perform statistical calculations on numerical data obtained, such as percentage of one phase in contact with another. Such studies may shed light on how these minerals form and why they are distributed as they are in ordinary chondrites and their chondrules.

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References: [1] Brearley A.J. and Jones R.H. (1998) *Planetary Materials, 36,* 3-1–3-7. [2] Van Schmus W.R. and Wood J.A. (1967) *Geochim Cosmochim Acta, 33,* 747-765. [3] Meteoritical Bulletin Database. < http://tin.er.usgs.gov/meteor/>. [4] Jensen J.R. (2005) *Introductory Digital Image Processing,* 116-117.