



# Compilation of historic mineral exploration data pertaining to the "lost" Crandon Cu-Zn deposit, Forest County, WI: Rediscovering Wisconsin's largest and most controversial massive sulfide deposit

Lucy M. Horst and Dr. Robert W.D. Lodge  
Department of Geology - University of Wisconsin Eau Claire

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## Introduction

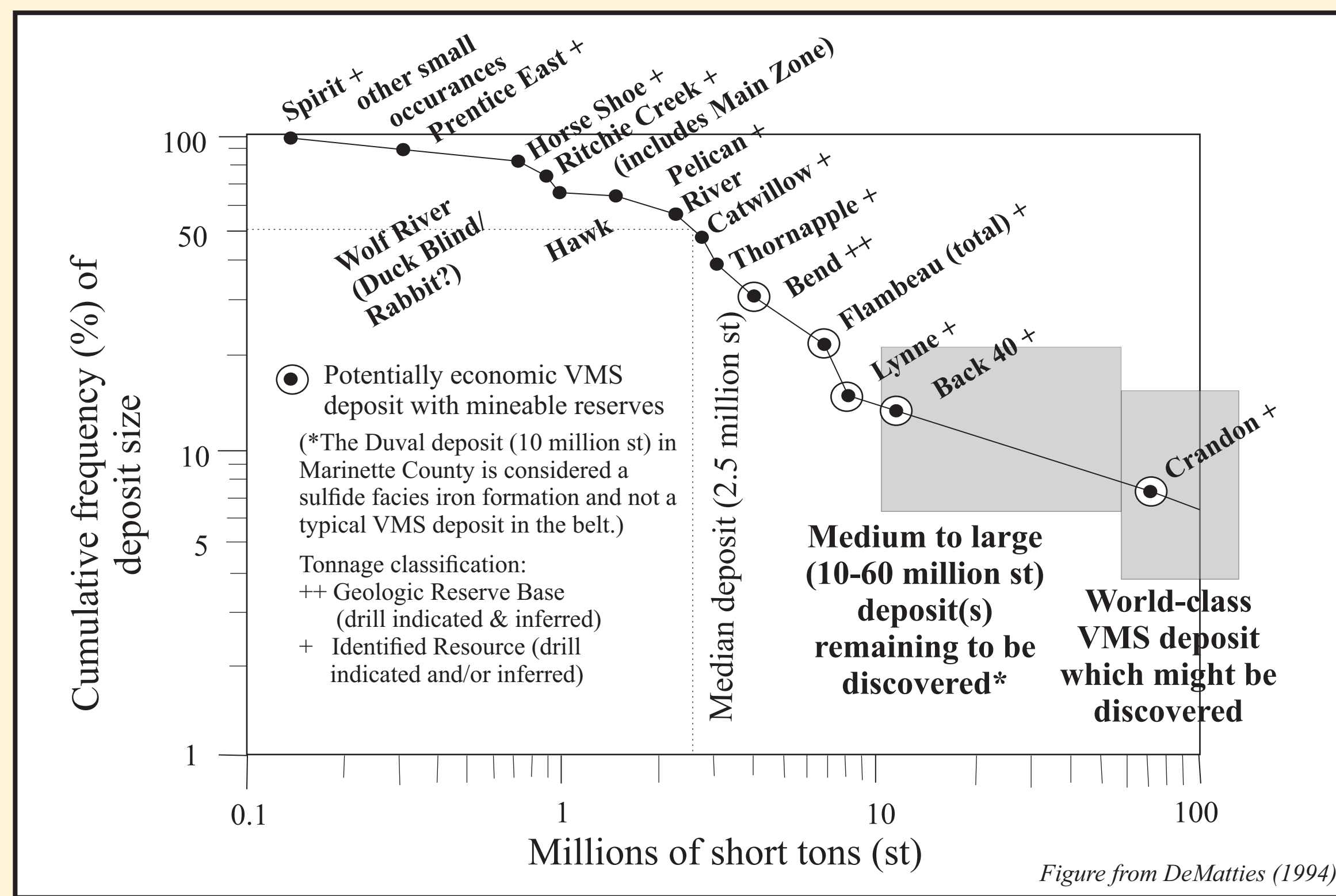


Figure 1. Tonnage distribution of known volcanogenic massive sulfide deposits and occurrences in the Wisconsin Penokean volcanic belt.

The Crandon massive sulfide deposit in Forest County, Wisconsin, is by far the largest polymetallic ore body in the Penokean Orogen. First discovered in 1976 by the Exxon Minerals Co., the company was eager to exploit the deposits over 60 million tonnes of Cu and Zn resources. After numerous years of exploration, the company filed a Notice of Intent to mine at the Crandon location in 1981. Despite numerous environmental and industrial regulation exemptions for mining companies by the state legislature, the Crandon mine project went on a hiatus due to low metal prices. This time period of inactivity at the Crandon site saw an increase of pro-conservationism in the public allowing the project to come under public scrutiny and controversial debate. Later attempts to permit the mine corresponded with new state and federal mining and environmental legislation that made permitting more difficult.

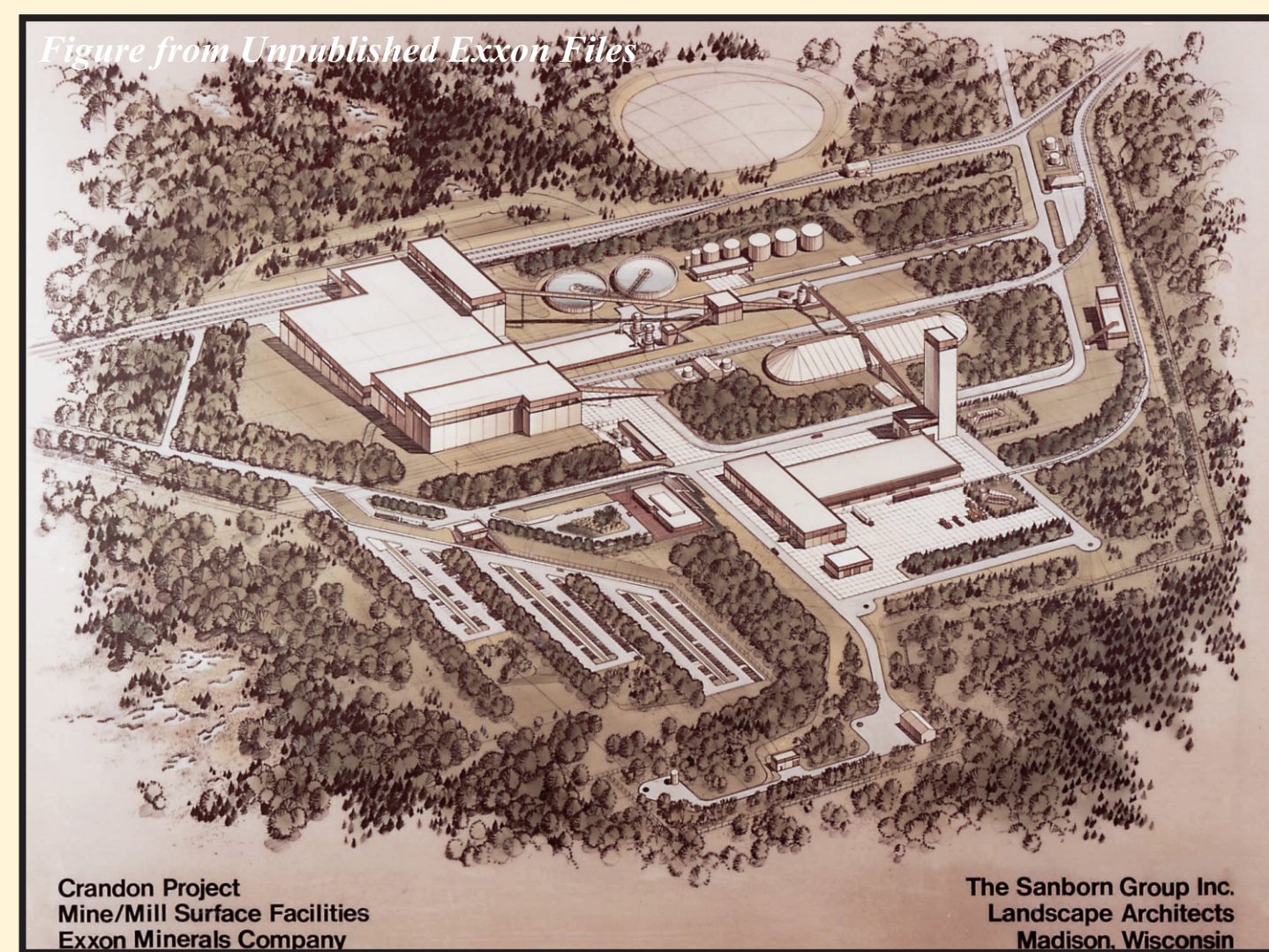


Figure 2. Proposed mine plan and infrastructure at the Crandon Deposit.

After numerous attempts to pass mine permit applications through the newer environmental regulations by several major mining companies, the project was shelved and never went into operation.

One of the most controversial topics for the environmental groups and Native American tribes that were actively protesting against the development was

the environmental impact from the extraction and processing of sulfide minerals and metals in the rock would have on the water, wildlife, and ecosystem of the surrounding area. Because of the constant pressure from protestors, expansive time and financial investments, and strict regulations the Crandon project was finally scrapped in 2003. The deposit and mineral rights were sold to the Sokaogon Chippewa Community and the Forest County Potawatami for \$16.5 million, permanently ending mine operations at the site. After this most data and information pertaining to the geology and mine were destroyed or lost. Not only was the deposit not mined, but there has been no research conducted on the deposit to extract the economic and geologic significant of this massive ore body. This project has compiled reports, maps, and rock samples stored at the Wisconsin Geological & Natural History Survey and the University of Minnesota-Duluth and have started to rediscover the geology of the "lost" Crandon deposit.

## Volcanogenic Massive Sulfide (VMS)

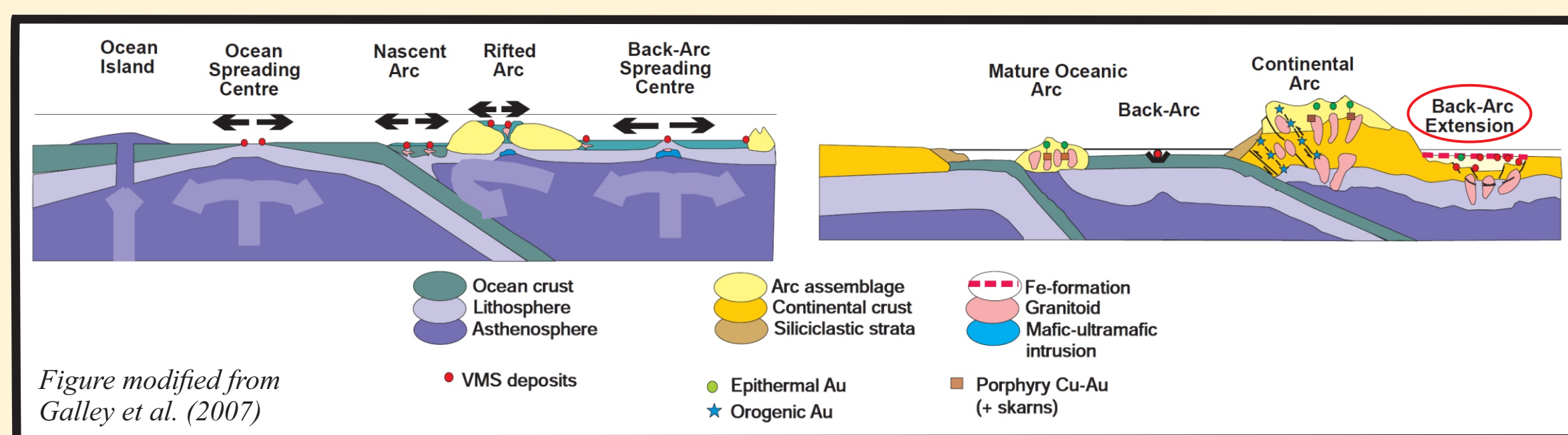


Figure 3. Metallogeny of volcanic arc tectonic settings.

VMS deposits, such as the Crandon deposit, are important sources of base and precious metals such as Cu, Zn, Pb, Au, and Ag (e.g. Galley et al. 2007). They are associated with extensional tectonic and volcanic settings. The lithofacies associations at Crandon are specifically associated with back-arc extension in a continental setting based upon the abundance of clastic material in the stratigraphy.

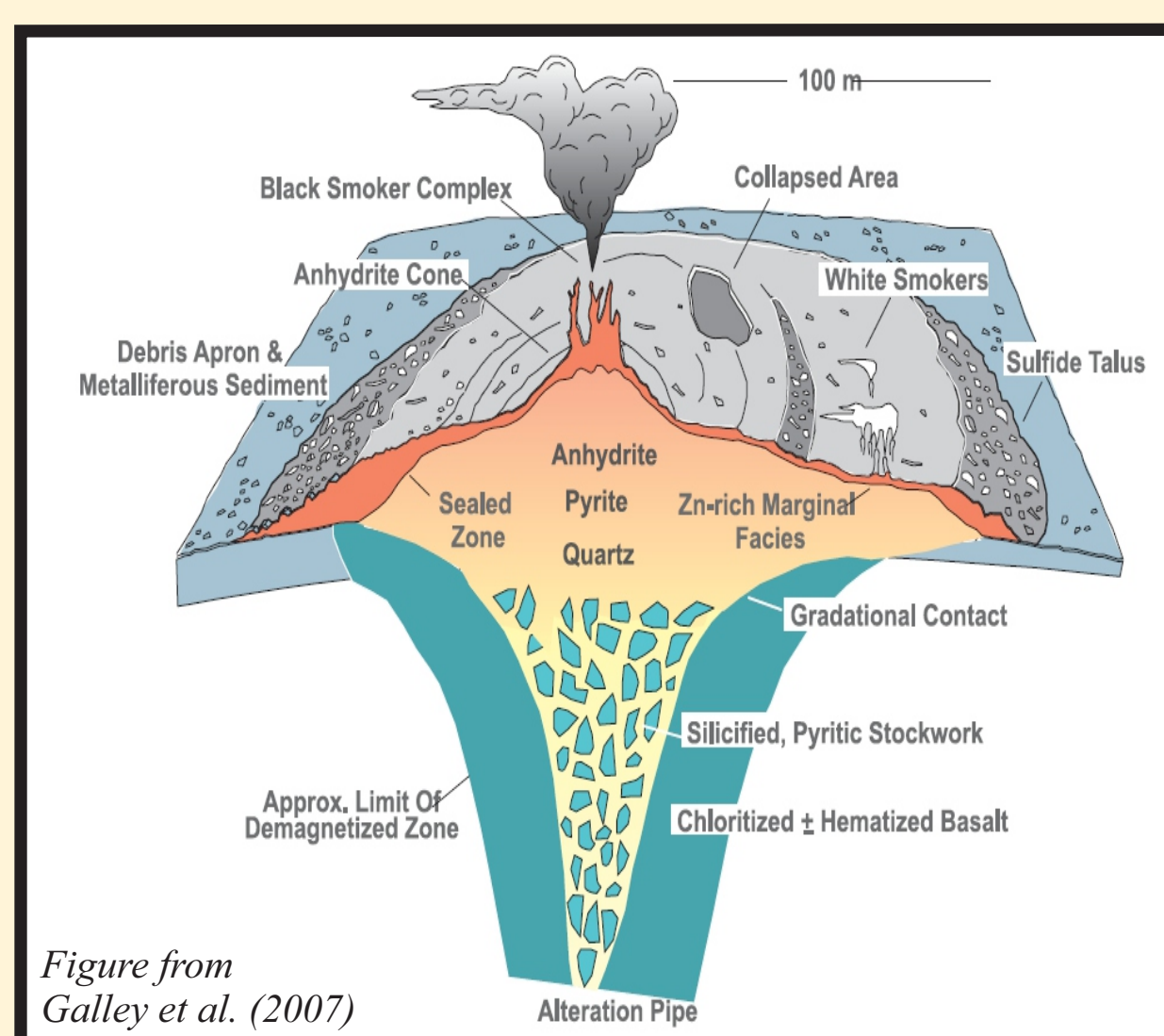


Figure 4. Models for VMS mineralization and hydrothermal vents. The discovery of "back smokers" on the sea floor at mid ocean ridges and submarine calderas have dramatically improved our understanding of the formation of VMS deposits. Hydrothermal vent systems leach metals from volcanic strata through hot seawater-rock interactions and re-precipitate them when the fluid cools at the surface. Types of precipitated metals are determined based on the composition of the surrounding rock and on the temperature of the water moving through the system.

## Crandon Stratigraphy and Core Samples

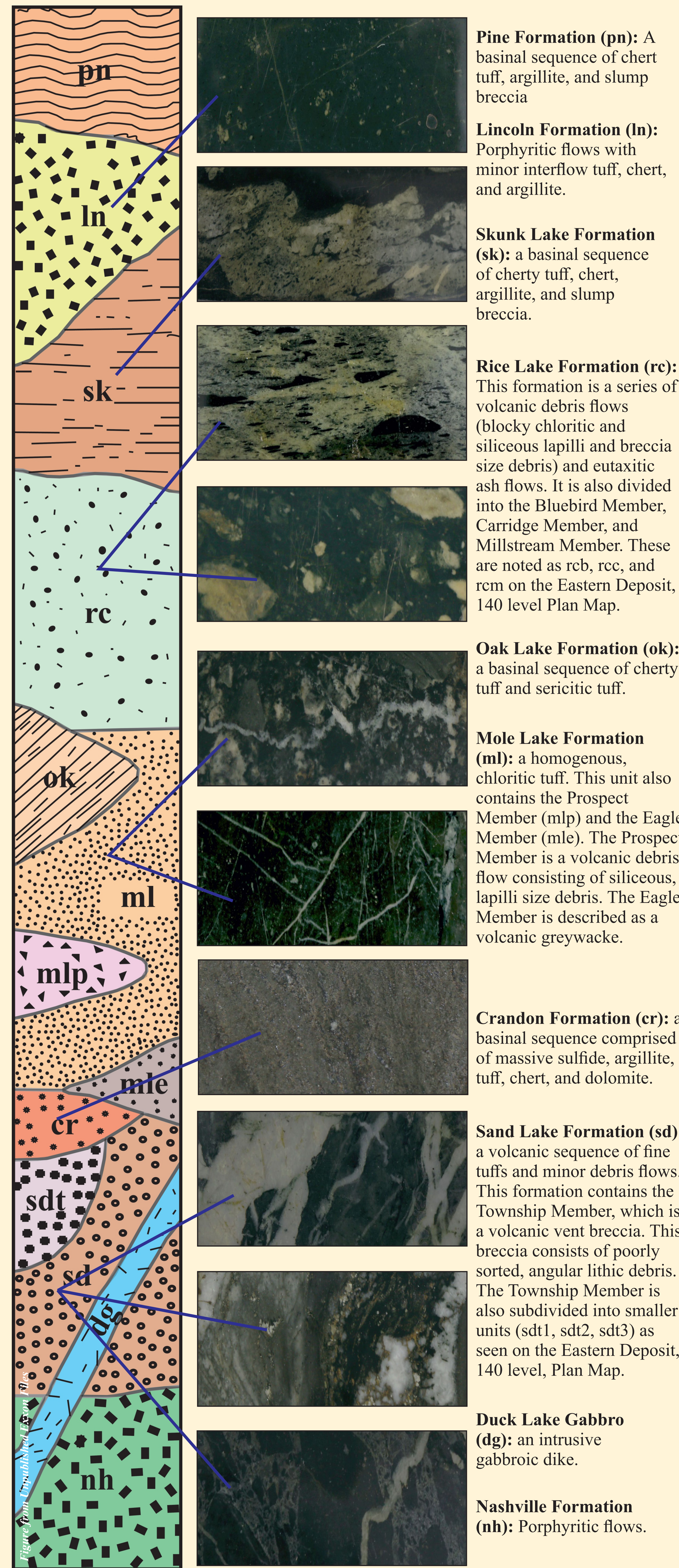


Figure 5. Generalized stratigraphic column of the volcanic strata hosting the Crandon Deposit. Unit descriptions compiled from Lambe & Rowe (1987), Dematties (1994), and unpublished Exxon files.

## References

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## Digitization of Crandon Geological Maps

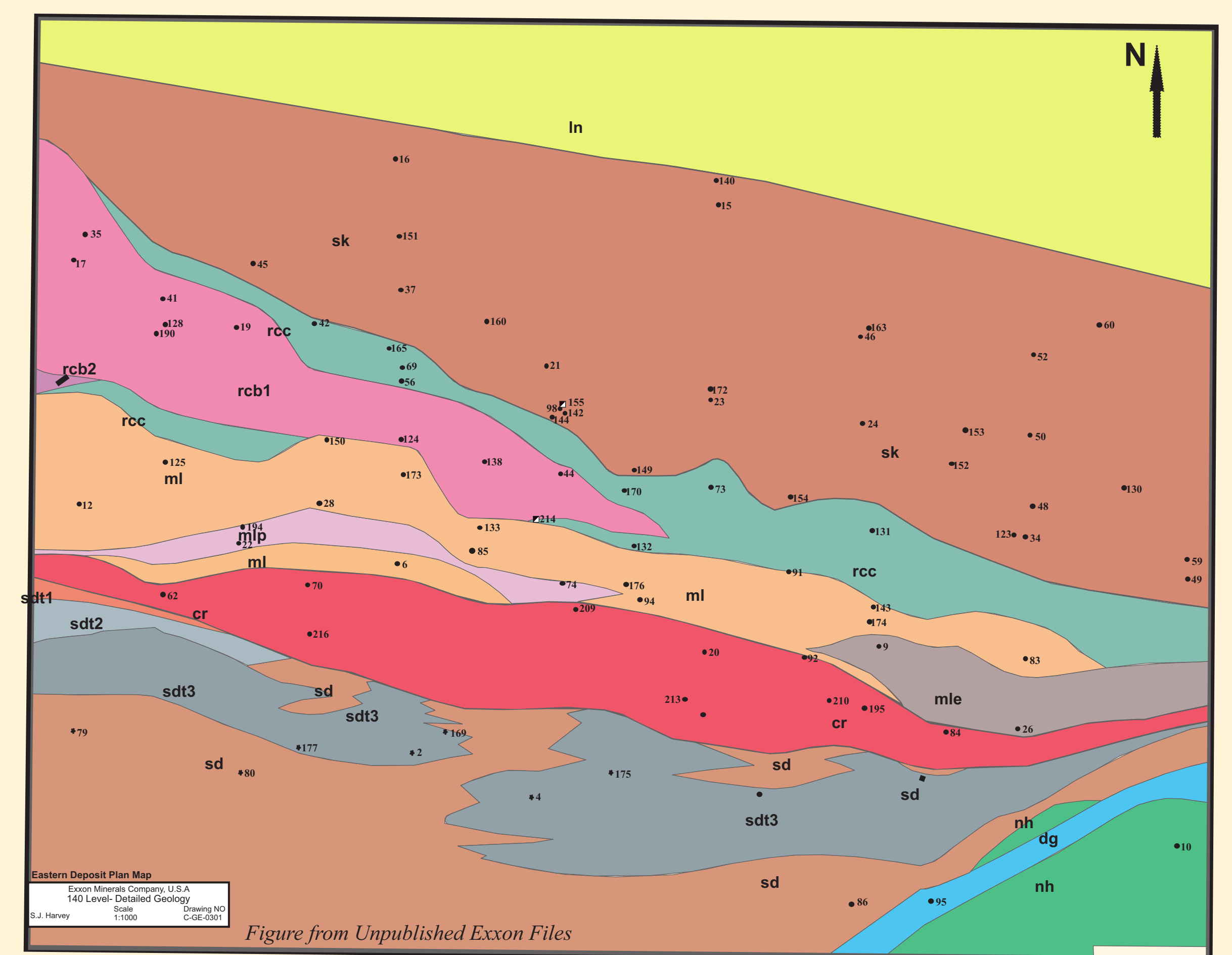


Figure 6. Surface and level plan geology for the Crandon Deposit.

During mine planning, several level plan geology maps were generated at varying depths through the deposit. Many of these were recently donated to the WGNHS and subsequently compiled and digitized in this study. Using the digitized level plan maps, a 3 dimensional reconstruction of the deposit can be created to further analyze the stratigraphy and location of samples. The Crandon Formation (cr), shown in red, hosts the massive sulfide deposit, which is predominantly zinc rich on the map above. Alteration of the surrounding stratigraphy is characterized by mineral depletion/addition and the presence of quartz veins.

## Geochemistry & pXRF Analyses

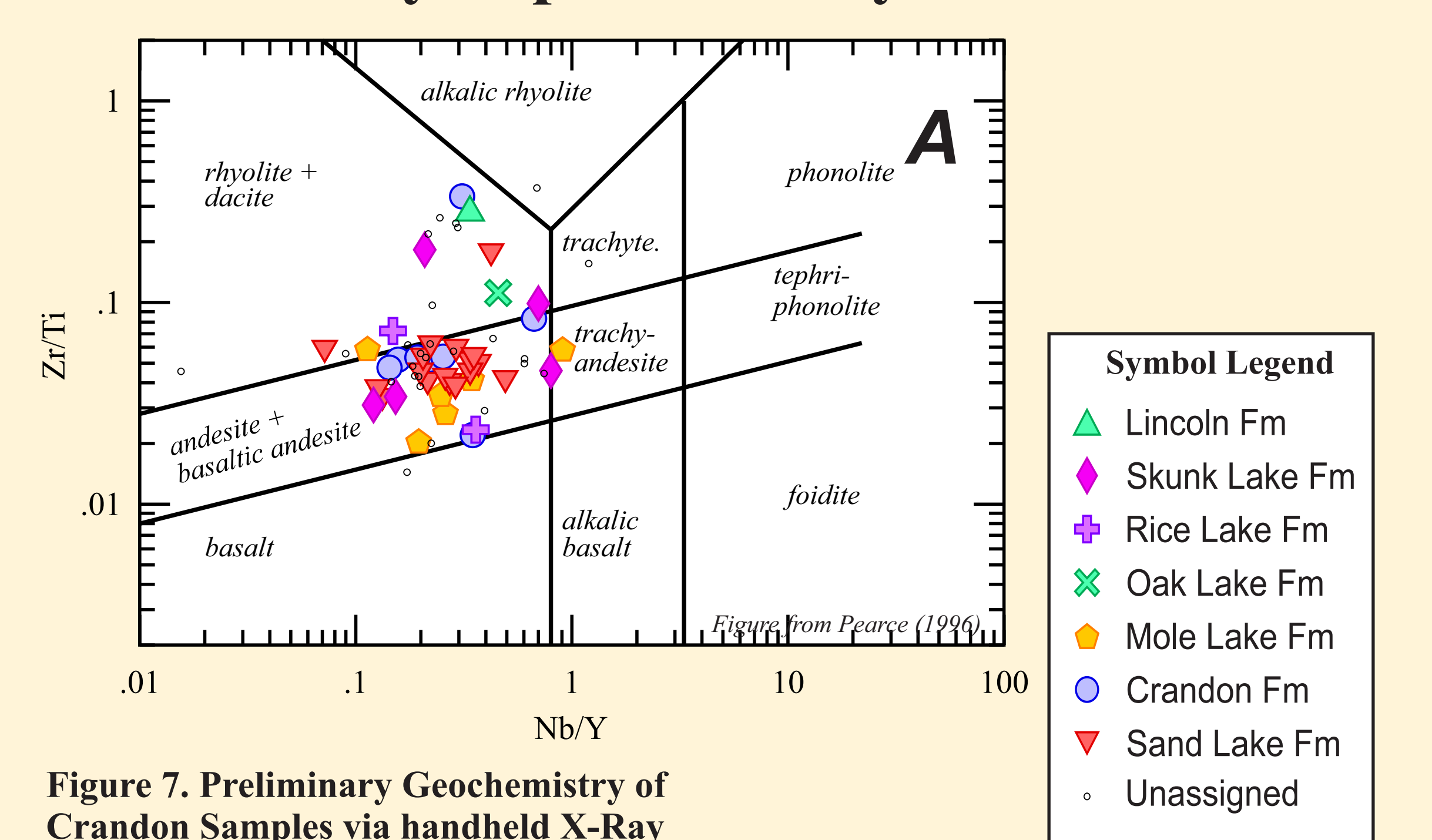


Figure 7. Preliminary Geochemistry of Crandon Samples via handheld X-Ray Fluorescence (pXRF)

A total of 106 rock samples stored at the University of Minnesota-Duluth were photographed and then analyzed using pXRF. This preliminary geochemistry was plotted to show protoliths and tectonic settings. This data will also be used to guide future sample selection for higher precision, destructive geochemical methods.

Despite significant scatter in the data due to lower precision data, there are some trends that can be observed. Firstly, the volcanic rocks that host the Crandon deposit are primarily intermediate to felsic in composition (A) that have been formed in a volcanic arc tectonic setting (B). Lithofacies associations supports an continental arc tectonic setting.

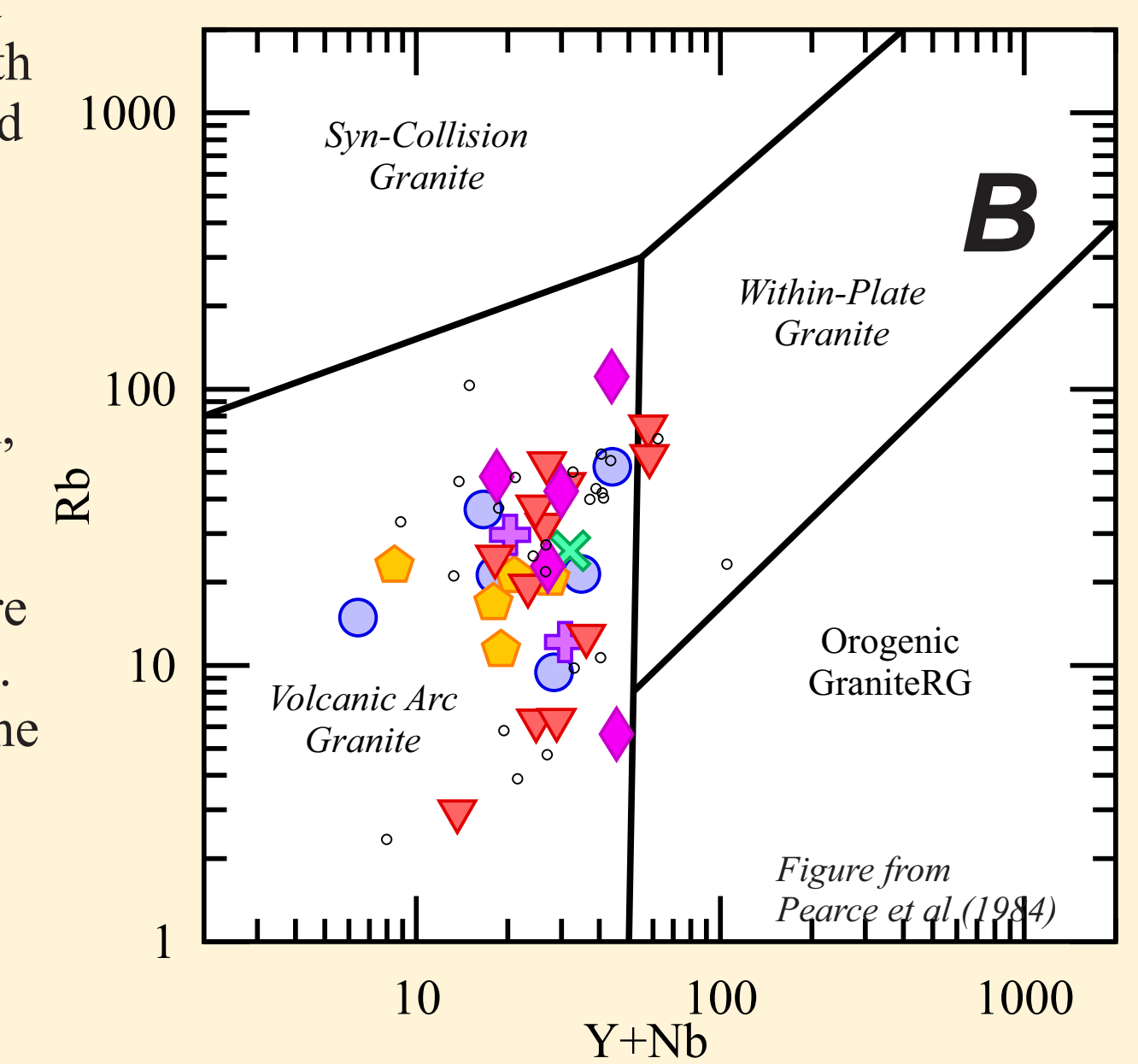
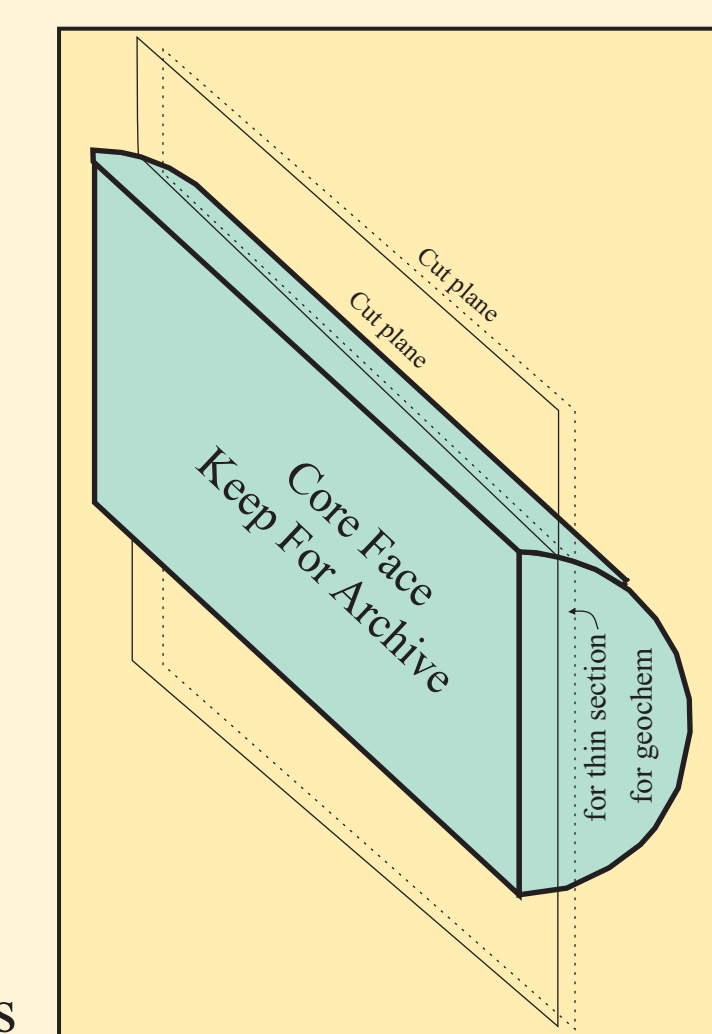


Figure 8. Future Analyses

## Conclusions

This project has so far been very successful in obtaining and organizing materials from the original exploration of the Crandon deposit. Furthermore, preliminary analyses have already yielded pioneering and important data pertaining to the stratigraphy, geochemistry, and formation of the Crandon deposit. This research has already fostered a renewed academic interest in the Crandon deposit and collaboration between UMD and UWEC. Future work will focus on 3D reconstruction of the deposit to determine the spatial context to samples and will guide future analyses.



Since the Crandon project has been shut down and core samples are exceedingly rare, preservation of samples is paramount. Special rock cutting methods with cut widths of <0.3mm commonly used with meteorites will allow us to fully characterize the samples while preserving an archival slab.