Archaeological Stones and Their Macroscopic Identification

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Dedicated to the memory of my grandparents

Fannie Kate (née Dezern) and Jesse Henry Harrell

and

Ethel Bethany (née Smith) and Thomas Carter Sharp

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Preface

During the over five decades that I have worked with archaeologists, many have expressed an interest in knowing more about how to identify the rocks and minerals they encounter in the field. They recognized that this capability is an important part of their overall understanding of an archaeological site. It is for these people that this book was written. It is hoped that other archaeologists will take a greater interest in rocks and minerals now that the information needed for their recognition has been compiled in one easy-to-use source. This book is the geological reference that I wish had been available to me when I was working on archaeological excavations and surveys in Egypt and other Middle Eastern countries. At the time, my only option was to carry a small library of mineralogy and petrology books with me into the field. Although this book's focus is on archaeological stones, it will also be useful to geology students as a first step in their mineralogy and petrology studies as well as to practicing geologists whose macroscopic identification skills need burnishing.

Two geologists read an earlier draft of this book and offered many useful comments: Dr. V. Max Brown (retired from the University of Toledo, Toledo, USA) and Dr. Leigh Bettenay (at the University of Western Australia, Perth, Australia). It is with gratitude that I acknowledge their assistance as well as that of others who offered helpful suggestions on specific aspects of this book.

Chapter 1: Introduction

1.1 Archaeological Stones

Pottery and worked stone are the most commonly encountered materials in archaeological excavations and surveys. The stones are comprised of 'minerals' and 'rocks', with the latter being granular aggregates of one or more types of minerals (Figure 1.1). The minerals were used as 'gemstones' for jewelry, amulets, seals, and other small decorative objects; sources of metals; and a miscellany of other purposes. Although they occasionally served as gemstones, the rocks were employed mainly as 'building stones' for temples and shrines, palaces and villas, fortresses, administrative and commercial buildings, tombs, roadways, and other monumental structures; 'ornamental stones' for statues and other sculptures, sarcophagi, stelae, funerary vessels, architectural elements in buildings, and other small to large decorative objects; and 'utilitarian stones' for tools, weapons, grinding stones, paint pigments, cooking and serving vessels, loom and net weights, and a large variety of other mundane applications. The identification of these rocks and minerals is an important part of any archaeological study. This goes beyond proper labeling. Knowing a stone's geological identity is necessary for determining its geographical source and, hence, also the trade routes and commercial relationships that brought it to its final resting place.

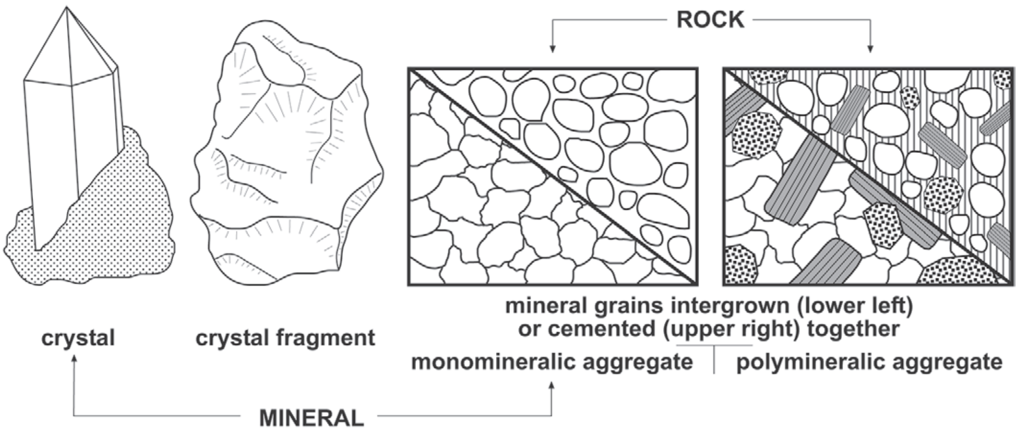

Figure 1.1: The distinction between mineral and rock.

Methodologies requiring sophisticated analytical equipment can be employed to accurately identify the rocks and minerals from archaeological sites, but these are expensive to use and usually require transporting samples long distances, and sometimes across national borders where export issues come into play. While some important samples may get such treatment, the vast majority of stones, for both economical and practical reasons, are identified by macroscopic means in the field or laboratory by members of an archaeological team (Figure 1.2). Sometimes these are geologists, but usually they are archaeologists with little or no formal training in 'mineralogy' (the study of minerals) or 'petrology' (the study of rocks). They have to rely on the many scholarly textbooks and popular guidebooks that have been published on rock and mineral classification and identification. The problem with these references, however, is that they are either too technical in their presentation, depend too much on properties that are difficult to determine, omit some of the useful and easy-to-perform tests, or do not include all the stones and other materials that archaeologists can potentially encounter. The intent of the present work is to avoid these shortcomings while providing archaeologists with a simplified and comprehensive explanation of how to recognize archaeologically important rocks and minerals. Also briefly included in this treatment are other materials found at archaeological sites that are sometimes thought of as 'stones', especially when occurring as small nondescript fragments in soils and sediments, but are technically neither rock nor mineral: e.g pieces of amber, bitumen, bone, ceramics, glass, ivory, and metal. Any of these materials can occur mixed in with the rocks and minerals, and so they need to be identified along with everything else.

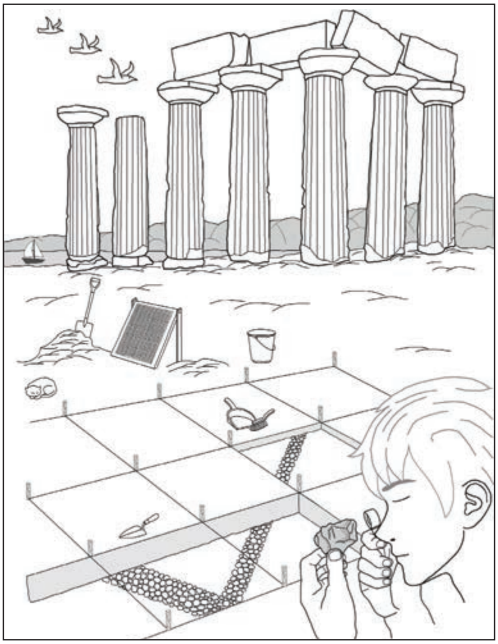

Figure 1.2: Identifying a stone at an archaeological site.

The term 'macroscopic' (or, synonymously, 'megascopic') in the context of this book refers to the properties of rock and minerals, and their test responses, that can be observed with the unaided eye or, at most, with a low-power magnifying glass. Such observations are made possible through the use of a relatively small number of inexpensive, simple-to-use tools and tests. These will be explained along with other information needed to identify minerals (Chapter 3) and rocks (Chapter 5). Also provided are determinative keys that guide the identification process. Recognizing rock and mineral varieties is made easier if you understand, in general terms, how they form, and so brief overviews are provided on the origins of minerals (Chapter 2) and rocks (Chapter 4).

Some of the determinative tests presented here are destructive in that they require either a small area on a specimen to be abraded or treated with a drop of dilute acid, or the removal of a tiny fragment for testing in a candle flame, or, after powdering, heating in a test tube. Other tests do no damage and merely require observation (e.g. color, external form, or internal structure) or wetting with water (e.g. to improve visual clarity or to allow measurement of specific gravity). Some specimens, owing to their delicate condition or great artistic or historical value, cannot be subjected to wetting or destructive testing; however, most of these will have a broken surface where some useful observations can be made. Knowing the identity of a rock or mineral is important, and it will often be the case that the minimal damage done to one small area on a specimen is an acceptable price to pay for the knowledge gained.

You may be aware of the several digital applications ('apps') for smart-phones and tablets, where you take a picture of a stone and the app tells you what it is. Some are free, but barrage you with advertisements, and others, with more features and no advertisements, require paid subscriptions. The big question, of course, is: do these really work? If they do, then there would be little need for a book like this one. The answer is: it depends. All these apps do is compare the picture you provide against a large database of pictures of rocks and minerals of supposedly known identity, and then try to find the closest match. This match is the identification of your unknown specimen. Tests have shown the identifications are accurate if you provide nearly textbook perfect pictures of common rock and mineral varieties that exhibit well-developed defining features. They are entirely unreliable, however, for everything else, including unusual varieties and less than ideal examples of the common varieties. This is due to both the incompleteness and inaccuracies of the database, which is made up of labeled pictures scoured indiscriminately from the Internet. Some of these stones are correctly identified but many are not. Additionally, for the pictured stones in the database, some have been correctly labeled, but according to different and often incompatible classification schemes which are not revealed to users and are probably unknown to the app developers. It is also unclear if the backgrounds in the photographs have been blanked out or if they contribute to how the app sees the stones. No doubt, the addition of an 'artificial intelligence' capability (i.e. a machine-learning neural network) to an app will improve its identification accuracy, but it will still be dependent on the quality of the database used to train it. It will, thus, require a considerable leap of faith to trust an app to identify your archaeological stones. It is far better to actually understand what you are looking at and this book will instruct you on how to do this.

Many guidebooks on rocks and minerals – such as the ever-popular ones by Mottana et al. (1978) and Pellant (1992) – include beautiful color photographs of every stone described. While these would seem to be a useful addition, I think they can do more harm than good because the photographs can be both misleading and a disincentive to making close observations. First, it is unlikely that your rock or mineral specimen will look exactly like or, in many cases, even similar to what is shown in the photograph. And second, when photographs are available, people tend to rely overly much on them at the expense of observing the more useful diagnostic macroscopic properties. Color photographs also add significantly to the cost of a book. For all these reasons, photographs are not included in the present work. They are not, in any event, essential for the identification of rocks and minerals.

While the identification process described in this book has been simplified to make it approachable for non-geologists, it cannot be said that it is simple. There is much to learn about rock and mineral properties, and the copious terminology that applies to them. It will also take time to master the observational tests and to be able to deftly navigate the determinative tables. Patience and perseverance, however, will usually guarantee a successful outcome. If you have not already done so, taking an introductory college-level course in 'Physical Geology' will help in providing context and perspective on the potential stone varieties. Alternatively, you can also get some of this background from Allen (2017), an introduction to physical geology written for archaeologists.

1.2 Rock or Mineral?

A basic definition of rocks and minerals has been presented in Figure 1.1, but, in practice, how does one actually recognize whether a given stone is a rock or a mineral? To arrive at this decision, you need to closely examine the specimen (using a hand-lens if necessary) and observe if it is visibly granular: i.e. an aggregate of many grains separated by distinct boundaries. This can be difficult to determine when the specimen's surface is rough, but the fine details can be brought out by wetting the surface with a thin film of water, clear spittle, or, better, mineral oil (the water-soluble laxative).

- If the stone does not appear to be granular, then it is either a mineral or a very fine-grained rock. If it exhibits a crystal form, even a partial one, it is a mineral. It is also a mineral if you can see one or more sets of parallel breakage surfaces throughout the specimen (i.e. cleavage planes as described in section 3.2.3.3). In the absence of these features, it will be difficult to distinguish between a mineral fragment and a rock with grains too small to be seen.
- If the stone is conspicuously granular, then it is a rock. However, if it appears that all (or nearly all) of the grains are the same mineral, then this monomineralic rock can also be considered as the aggregate form of a mineral.

Further observations, as explained in Chapters 3 and 5, will usually reveal the specimen's true identity: i.e. the specific rock or mineral variety.