Appendix 1: PROPERTIES OF MINERALS

The properties of minerals may be generally divided into:

- Properties related to the crystal structure
- Properties based on the interaction of minerals with light
- Mechanical properties
- Properties related to the mass of the mineral
- Other diagnostic properties

Below we provide guidance for school descriptions, which in some cases differ from geological descriptions of the same characteristic. The description of the mineral is adapted to the level of teaching at the elementary and secondary schools. Students determine these properties with the help of appendix 3.

Properties of minerals

Properties related to the crystal structure

CRYSTAL SHAPE: The description of the crystal shape property refers to the external manifestation of the internal arrangement of the atomic structure in the crystal. In this property, students observe the pattern and use geometric names to describe the shape of the mineral. In the lower grades of elementary school, a cross-curricular connection to mathematics can be established; in the upper grades of elementary and secondary schools, students can already be expected to describe the shape of the crystal.

Properties based on the interaction of the mineral with light

LUSTER: The property of a mineral that describes the amount of light reflected from its surface is called luster. This is a subjective assessment based on the appearance of the sample. Luster is divided into three categories: Metallic, Semi-Metallic, and Non-Metallic. Metallic luster gives a brilliant, reflective appearance, like a metal. Semi-metallic luster is a transitional category and is like metallic luster but duller because there is less light reflection. Non-metallic luster is characteristic of colorless and light-colored minerals.

COLOUR: Minerals may be colorless or colored. You can always describe the color of the sample, but it is not the main property for identifying minerals. Minerals do not always have a characteristic permanent color. When they are colored because of additions and inclusions in the mineral, geologists call them allochromatic minerals, which means that the color depends on the type and amount of additions. The color of the mineral can also be a characteristic feature. We call these minerals idiochromatic. These are minerals in which the chemical element that gives a mineral its color is an essential component of the mineral. These minerals have often been used as natural dyes or natural pigments. Therefore, minerals

have fixed color when the color is directly related to the chemical composition and mineral structure.
CAUTION! Minerals can change the color on the surface; therefore minerals must always be observed on a fresh surface!

STREAK COLOR: Is a color of a mineral in its powdery form. It is usually obtained by scraping the mineral on a hard white surface, such as a tile of unglazed porcelain, producing a line or streak of fine powder. The color of the streak is usually constant for a given species of mineral, although the mineral may vary greatly in color in the field. In fact, the color of a streak may vary considerably from the color of the unpowdered mineral. Streak is one of the most useful diagnostic features, as it provides a quick way to distinguish between different minerals that are otherwise similar in appearance. The hardness of the ceramic tile is 6.5 (according to the Mohs hardness scale), therefore it cannot be used for minerals with higher hardness.

TRANSPARENCY: It is a measure of the amount of light that pass through the mineral. Minerals can be transparent, they let the light completely through (example: we can look at objects through a transparent mineral). They can be translucent, they let light through, but worse and more diffuse than transparent minerals (example: outlines of objects are not sharp when looking through a mineral). Minerals can also be opaque. They are completely opaque to visible light, even at the thin edges of the mineral. These are usually metallic minerals.

Mechanical properties

CLEAVAGE: This is a mineral property in which, when a force is applied, certain surfaces parallel to one of the crystalline surfaces are cleaved (the inner faces of the weakness). For teaching purposes in elementary and secondary schools, cleavage is divided into: Perfect, Good, Distinct, Poor, and Absent. Minerals with perfect cleavage will after cleavage (application of force to a mineral), disintegrate without leaving no jagged, rough edges, and will also form even, smooth surfaces after breaking apart. Minerals with good cleavage still leave a smooth, flat surface after cleavage, but remnants of a rough surface can be observed in some places. Distinct cleavage is when, after cleavage of a mineral, most of the newly formed surfaces are straight and jagged. Only rare parts are completely flat and smooth. Poor cleavage is characteristic of minerals that leave no well- defined surfaces after cleavage, but on close examination it seems to us that the mineral is not completely randomly fractured. In the absence of cleavage, minerals leave an irregularly shaped surface after cleavage, which is rough and has no uniform planes. In elementary schools' students can also just determine if mineral has cleavage or not.

HARDNESS: Is a property we use to describe the resistance of a mineral to the action of a mechanical force. We distinguish relative hardness, which tells us whether the mineral is harder or softer than another mineral or from a material with known absolute hardness, which is measured with a sclerometer (a device used to measure the absolute hardness of minerals). The device determines the hardness of the mineral by slowly increasing the pressure on the diamond tip as it moves across the mineral until the "scratch" occurs. To

describe minerals in the learning process, we use the Mosh scale as well as some common objects of known hardness. The hardness of the minerals is then compared to each other and to objects of known hardness to determine the relative hardness. It is important to understand that the difference between relative and absolute hardness is not the same between levels of the Mohs's relative hardness scale.
To perform the hardness test, students place the mineral on a tabletop and place a tip of the reference object against a flat, unmarked surface of the mineral. They press the reference object firmly against the mineral and intentionally drag it across the flat surface. In the case of a glass slide, they pull the mineral against the glass. If the object scratches the mineral or vice versa, it means that the mineral or the object has a lower hardness than the object.

Properties related to the mass of the mineral

SPECIFIC GRAVITY: Specific gravity or "relative density" (G) indicates the ratio between the mass of the substance and the mass of the same volume of water at 4 ° C. For example, a mineral with a specific gravity of 2 weighs twice as much as the same volume of water. Specific gravity testing is a non-destructive technique for determining minerals that might be too damaged by other tests. The average specific gravity for non-metallic minerals is G = 2.65 to 2.75 and for metallic minerals G = 5.0. For accurate determination, the mineral must be homogeneous, clean and compact, without residues, voids or cracks in which bubbles or air films can be trapped. For accurate determination, the force measuring device (force meter) is used and the procedure described below is the procedure for the basic tests.
We need a net for a mineral, a glass/container of water, and a force meter. The mineral is placed in a net and then attached to the force meter. First, we measure the strain (weight in N) in air. Then we completely immerse the net with the mineral in water and also measure the strain (weight in N) in the water. Then we calculate the specific gravity of the mineral using the following formula:

$$\text{Specific gravity} = \frac{\boldsymbol{weight\ in\ air}}{\boldsymbol{weight\ in\ air - weight\ in\ water}}$$

Other diagnostic properties

MAGNETISM: In a strict sense, this is the ability of a mineral to attract a magnet. We know several types of magnetism: 1) Ferromagnetism, when the mineral acts as a permanent magnet and attracts a small hand magnet (e.g., magnetite (Fe3O4)). 2) Paramagnetism, when minerals with Fe in their field attract a strong magnet. 3) Diamagnetism is a property when minerals without Fe, in their field repels a strong magnet. Common magnetic minerals are Fe-Ti oxides and Fe sulfides, and weakly magnetic are non-Fe minerals and Fe-paramagnetic minerals. For the school description of minerals, we describe ferromagnetism. We define this property as a mineral is magnetic or is non-magnetic.

REACTION WITH ACID: Some minerals react with various acids and dissolve. For some minerals this process is slow, which is why we say the mineral is soluble, while for others the reaction is turbulent (bubbles are released - the production of CO2 causes foaming and noise, the reaction is visible and audible). Where the reaction is turbulent, the term reacting is used to describe it. As working with acids is dangerous in school settings, we only use the dilute hydrochloric acid. We use 10% or 1 molar HCl. If we consider that the room or the maturity of the students is not suitable for handling dissolved HCl, alcoholic vinegar can be used. In this case, the reaction is slightly less turbulent. The temperature of the acid is also essential. For example, in reaction with cold HCl, for example calcite, reacts violently, but there is no reaction with dolomite. Dolomite reacts only with HCl heated above 30° C. To make the experiment suitable for use in the MineralCheck toolkit, cold HCl must be used.

SENSORY PROPERTIES: This is a subjective description that can often tell us the diagnostic property of a mineral. These properties are related to other characteristics of the mineral, such as specific gravity, conductivity, chemical composition... Minerals have different specific gravity, so the same large samples of minerals can be heavier or lighter. Also, some conduct heat better than others and so may feel cold or warm to us. Because of specific chemical properties, some minerals may have a specific smell (sulfur smells like rotten eggs) or taste (halite – NaCl is salty).
CAUTION! Some minerals are toxic, so the taste test is not done with all minerals, but only with those we know are suitable!