ENGLISH FOR GEOLOGY STUDENTS

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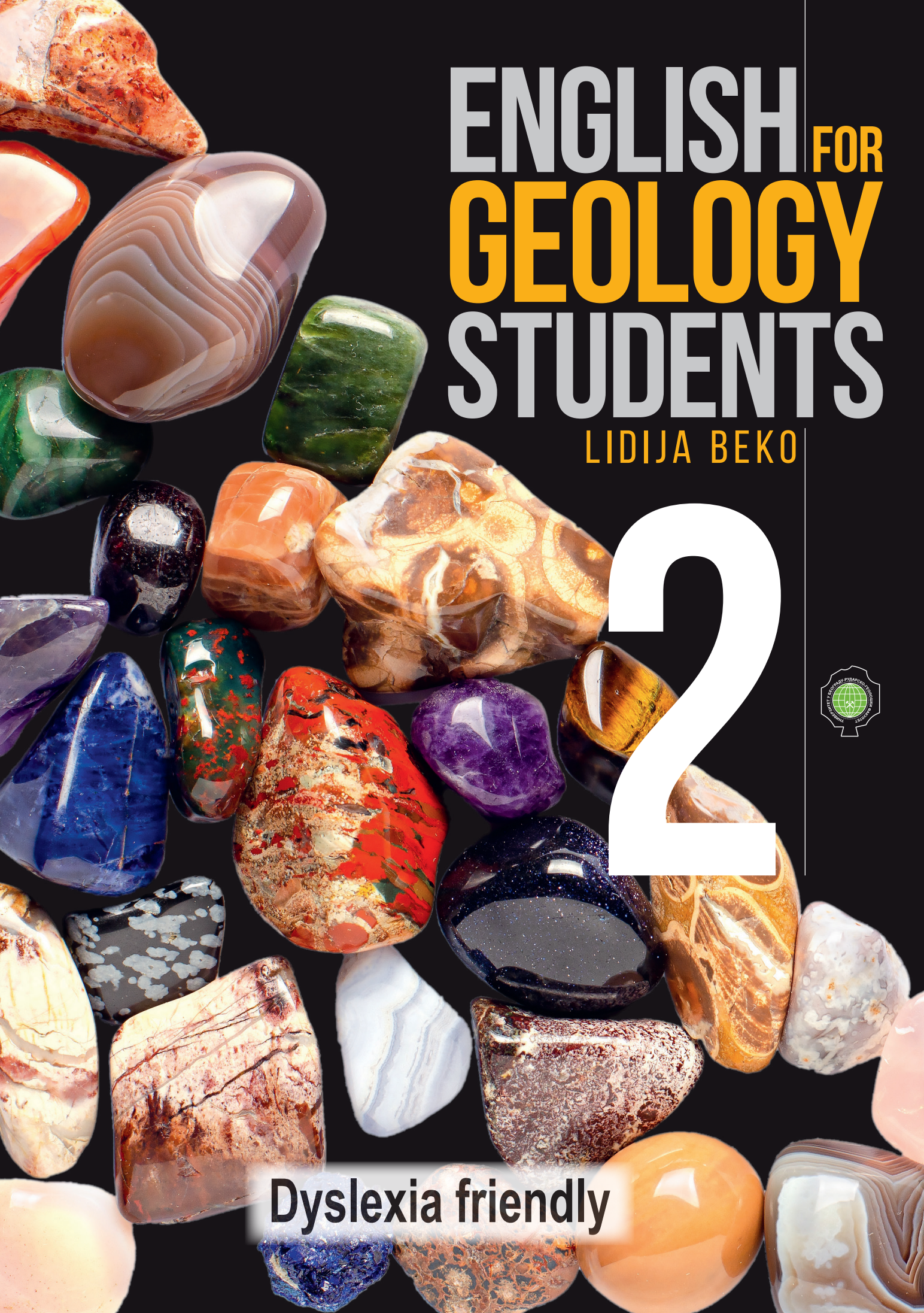

Dyslexia friendly

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ENGLISH FOR GEOLOGY STUDENTS 2

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Part 2 Metamorphic textures

Garnet in gneiss and slate

The manner in which mineral grains are arranged in a rock, in combination with their size and shape, is what gives rock its texture and structure (or fabric). The generally random arrangements in sedimentary and igneous rocks, which produce patterns which look the same no matter what angle they are viewed from, are in contrast to the preferred orientation displayed by the grains of some deformed metamorphic rocks. When these contain micas (platy minerals) or hornblende (elongate, prismatic minerals), there is likely to be a regular parallel or sub-parallel organisation of grains, forming planar sheets, giving the rock foliative fabric. Such rock fabrics are encouraged by differential stresses, which create mineral grains aligned in roughly parallel patterns. The terms distinctive or strong and slight, weak or poor are used to further describe foliation patterns, the former when it is strongly accentuated, the latter in the opposite case.

The fabric of a rock also dictates its cleavage, the manner in which it cleaves or fractures. Slate, which forms when shale or mudstone (rock composed of clay) undergoes low-grade metamorphism, exhibits a very distinct cleavage pattern, known as slaty cleavage, producing regular planar forms. Exposed to the higher temperatures and pressures of high-grade metamorphism, the mica and chlorite in slate form much larger grains than in other cases – large enough, in fact, to be discerned with the naked eye – and when they form a layered or planar structure, the foliation of the rock is termed schistosity. Schists and gneisses, as rocks exhibiting this type of foliation are called, tend to display wavy or uneven fracture patterns. As the individual mineral grains can be seen and identified, they are often added to the name of the rock, for example muscovite schist.

Foliated metamorphic rocks

- Slate, as mentioned above, is formed by the low-grade metamorphism of mudstone or shale in which pressure causes clay particles to realign and develop at right angles to the direction of the pressure. Containing the smallest mineral grains of all the metamorphic rocks, slate has traditionally been used as a roofing material because of the thin, even sheets slaty cleavage allows it to separate into.
- Schist, formed at greater temperatures and pressures than slate, is a coarser grained rock containing larger platy grains of muscovite and/or biotite (micas). Its

foliation – schistosity – is determined by the orientation of the platy constituents.
- Gneiss, another medium to coarse grained rock in which predominantly granular and elongated minerals form bands, usually fractures in irregular patterns, although some examples may contain layers of platy minerals (micas) where splitting may occur.

Nonfoliated metamorphic rocks

Metamorphic rocks which lack foliation are termed nonfoliated, and tend to form when the absence of stress and shearing means they are not subject to deformation. The minerals that form or re-crystallise during their metamorphism (calcite or quartz, for example) are commonly equant or equidimensional – their diameters are approximately equal in whatever direction they are measured.
- Marble, formed from the metamorphism of limestone or dolomite, consists of relatively soft minerals (calcite, dolomite - a score of 3 on the Mohs scale). This means that it has always been popular for creating statues, as it is easy to cut and shape. While white marble is the most popular in this respect, it can also be black, green or pink, depending on other minerals it may contain albeit in minor quantities.
- Quartzite, formed by the moderate- to highgrade metamorphism of quartz-rich sandstone, is a very durable metamorphic rock (Mohs score of 7). The nature of the recrystallisation, in which the grains bond very strongly together, means that quartzite breaks across the grains, rather than along their edges. As with marble, its colour can be affected by impurities, producing white, grey, purple and green variants, among many others.

Porphyroblasts

Porphyroblastic rocks represent a third common texture for metamorphic rock, in which large grains form in a matrix of finer grained minerals. They develop across a broad range of metamorphic conditions and from a similar broad range of parent rocks. In the process of metamorphism, minerals such as garnet or andalusite have a tendency to recrystallise as a few very large crystals (porphyroblasts), while muscovite or quartz, for example, have a tendency to reform as a much greater number of much smaller crystals. For example, if the action of metamorphic agents on a parent rock produces garnet, biotite and muscovite, the resulting porphyroblastic rock will be a background matrix of fine-grained muscovite and biotite containing large garnet crystals.

Mineral Changes

Minerals display stability under certain temperature and pressure conditions. This can be seen in the way different minerals crystallise out of molten lava at specific temperatures in the formation of igneous rocks. The same process occurs in metamorphism, only in what is termed solid-state transformation: temperature and pressure cause the minerals to recrystallise in new forms, although the rock remains solid throughout this process. The newly formed minerals remain stable under new conditions. A process of observation and experimentation has allowed scientists to determine the temperature and pressure conditions at which specific minerals form; hence, when such metamorphic rocks are found, it is possible to understand the conditions which existed at their location in the crust during their recrystallisation.

Compositional changes

Metamorphic rocks tend to retain the same basic chemical composition as their parent rock, for example gneiss shares a basic chemical composition with its parent, granite. However, it is also possible that compositional changes will occur alongside with the more usual textural and mineralogical alterations. This is most frequently the result of contact metamorphism caused by igneous intrusions and/or the action of hydrothermal liquids. This type of change is responsible for the formation of various contact metamorphic rocks as well as of deposits of ores such as gold, copper and zinc.

Mixed conditionals

Mixed conditionals are types of conditional sentences in which the hypothetical present and hypothetical past intertwine to create an unreal scenario in order to express an accentuated hypothesis.

There are two types of mixed conditionals.

Type I – unreal past which could have influenced and thus created an unreal present

ex. **If I <u>hadn't completed</u> my studies, I <u>wouldn't be</u> eligible for this scholarship now.** (But, I did complete my studies and I am eligible for the scholarship in the present.)

If she <u>had won first place</u>, she <u>would be famous</u> now. (But, she did not win first place, so she isn't famous now.)

Notice that in the IF-clause we have past perfect (for unreal past) and in the main clause would + inf. (used for hypothetical present/ future). Simply put, the mixed conditional type I is a combination of the III and II conditional.

Type II – unreal present, general state which could have influenced and altered a past situation

ex. **If I <u>were</u> you, I <u>would have told</u> him to do his research.** (But, you are not me, so you reacted differently.)

If she <u>knew</u> what the Wilson cycle is, she <u>wouldn't have asked</u> for an explanation now. (But, she doesn't know about it in general, so she had to ask for an explanation.)

Notice that in the IF-clause we use the Past Simple tense (hypothetical present) and in the main clause would + perf.infinitive (unreal past). Simply put, the mixed conditional type II is a combination of the II and the III conditional.

Azurite

sign of confidence and mastery of the topic/ issue at hand, as well as refined speaking skill.

Emerald, the Greenest of Greens

Myth:

Ancient civilizations were in awe of the emerald. They revered it, but also recognised some dark quality in its greenness that conveyed misfortune. That is best observed in a Colombian myth about how emeralds were created.

There was a lonely god called Are who enjoyed the beautiful world he had created but longed for other beings. Thus, he created a man, Tena, and a woman, Fura. They were given eternal youth, health, and peace, as long as they were faithful to each other.

One day, Fura met a handsome man, Zarbi, and felt new sensations within her: curiosity, excitement, and guilt towards Tena. When her husband found out about her betrayal with Zarbi, he became so angry and hurt that he stabbed himself. Fura repented her deeds, but it was too late. As Tena lay lifeless on her knees for eight days, she cried tears of misery, and the tears turned into emeralds when the sun shone upon them.

The story suggests emeralds carry the weight of many dark emotions, including infidelity.

At the same time, the gem was cherished throughout Asia, the Middle East, and the Americas for its beauty and power. It was the mighty Cleopatra's favourite stones and she loved to adorn her royal attire with them. Egyptian kings were found buried wearing emeralds, because they believed the stone would give them eternal youth in the afterlife. The Incas used emeralds for decoration and religious ceremonies.

The Greeks were the first to associate the emerald with love and Aphrodite, their goddess of love. Aristotle believed the emerald had the power to cure epilepsy, poor eyesight, and endow a person with eloquence. The Romans also had a saying about the gemstone, with their famous Pliny the Elder explaining that "nothing greens greener" than the emerald.

Geology:

The first references to the emerald appear in documents about Babylonian trade around 4000 BC, and the first known mines were in Egypt, where mining probably began in the 1st century BC.

Emerald is a very rare gem. It is composed of the mineral beryl and traces of chromium and sometimes vanadium, which give the stone its fascinating green colour. However, beryl is usually present in places with different conditions than those that enable the appearance of chromium and vanadium. So all three elements being bonded together in the same location to create an emerald is a rare coincidence. The ratio of each element in the stone determines the emerald's shade – green, bluish green, or yellowish green. For example, Colombian emeralds are famous for their vivid bluish green colour that results from the combination of shining chromium, levelled vanadium and lower quantities of iron.

Emeralds formed in the Earth's crust millions of years ago. Similar to diamonds and rubies, emeralds also needed the right combination of extreme heat and pressure to be created within the Earth.

Geologists recognise three types of emerald deposits: a) the desilicated pegmatite that formed when metasomatic fluids interacted with beryllium rich pegmatites that intruded into chromium or vanadium rich rocks, b) sedimentary rocks, and c) metamorphic-metasomatic deposits. All of them required some tectonic activity to initiate the mineralisation of emeralds.

https://www.mdpi.com/2075- 163X/9/2/105/htm

Debate statement:

"What makes emerald so rare and are they valued because of their rarity?"

Phrases to use from the "Delaying Strategies" GROUP:

• That is a very good question, yes, and now, come to think of it, I would say… (e.g. that emeralds may be valued for their rarity to some extent.)

• Oh, what an interesting question, what I would say is… (e.g. that the rarity of emeralds isn't the only thing that determines their value,

because in that case they would be more valuable than diamonds.)

• Well, that's a rather difficult question, if I dare say so ... (e.g. Obviously, they are rare because of their composition and the scarcity of the mineral beryl and how infrequently it is bonded with chromium and vanadium.)

• Well, it depends on what you mean. If .... (e.g. you talk about the emerald's price, then it may mean more how durable the stone is, how many carats it has, how clear it is, etc. If you talk about its significance and mythic value, its rarity may be more of a factor.)

Emerald