دانشگاه زنجان

زبان تخصصی

برای دانشجویان مهندسی معدن

تالیف:

دکتر صادق کریم پولی

زبان تخصصی برای دانشجویان مهندسی معدن

Technical English for Student of Mining Engineering

تالیف :دکتر صادق کریم پولی

University of Zanjan

Technical English

For Studens of Mining Engineering

By : Sadegh Karimpouli (Ph.D)

ISBN:978-964-8885-69-0

University of Zanjan

Technical English

for Students of Mining Engineering

By: **Sadegh Karimpouli**

Assistant Professor of Mining Engineering Group

Engineering Faculty- University of Zanjan

Table of contents **Page**

Preface

On the light of the recent changes in Mining Engineering field by the Ministry of science, research and technology, some courses and syllabuses are displaced or changed. One of such courses is *Technical English*, which instead of focusing on a single field, it contains a general view in all fields, ranging from geology, explorations, mining and mineral processing. The present book is, therefore, organized based on the new syllabuses.

This book contains four chapters about geology, mineral exploration, mining and mineral processing. In each chapter, there are three lessons, each of which consists of four parts. First part is the main body. The idea is to prepare a thorough text containing the most essential words of subject of the lesson. To do so, several reference books are used. Second part is the practice part composed of comprehension tests extracting from the main body and close tests. The subject of each close test is a detailed topic related to its lesson. More new words are usually presented in this practice. Third part is a mini dictionary of the lesson. It is collected from some of the available dictionaries, such as 'Geology words' by Dr. Farid Mor and 'Basic words and expressions of mineral exploration, mining and mineral processing' prepared by President deputy strategic planning and control. Fourth partis considered to provide extra texts for those who are interested in reading more. Besides, all the used reference books are presented for further studying.

I want to thank **Eng. Milad Rahimi** who prepared an Android based software (TESME) including mini dictionaries of all lessons for students who are interested to review new words on their smart phones. Please contact to the author to access this software.

Finally, it must be mentioned that this book is the first try to fill such a gap in this course. It definitely contains many defects. All feedbacks about this book are welcomed by the author.

Sadegh Karimpouli (PhD)

Assistant Professor of Mineral Exploration,
Mining Engineering Group, Faculty of Engineering,
University of Zanjan
Email: s.karimpouli@znu.ac.ir
February 2016

To my parents

To my wife

Geology

1. Introduction to Geology

The science of Geology is concerned with the Earth and the rocks of which it is composed, the processes by which they were formed during geological time, and the modeling of the Earth's surface in the past and at the present day. The Earth is not a static body but is constantly subject to changes both at its surface and at deeper levels. Surface changes can be observed by engineers and geologists alike; among them erosion is a dominant process which in time destroys coastal cliffs, reduces the height of continents, and transports the material either to the sea or to inland basins of deposition. Changes that originate below the surface are not so easily observed and their nature can only be postulated. Some are the cause of the slow movements of continents across the surface of the globe; others cause the more rapid changes associated with volcanic eruptions and earthquakes.

1.1. Rock and minerals

The term *rock* is used for those materials of many kinds which form the greater part of the relatively thin outer shell, or crust, of the Earth; some are comparatively soft and easily deformed and others are hard and rigid. They are accessible for observation at the surface and in mines and borings. Three broad rock groups are distinguished, on the basis of their origins rather than their composition or strength (Figure 1):

a) *Igneous rocks*, derived from hot material that originated below the Earth's surface and solidified at or near the surface (e.g. basalt, granite, and their derivatives).

b) *Sedimentary rocks*, mainly formed from the breakdown products of older rocks, the fragments having been sorted by water or wind and built up into deposits of sediment (e.g. sandstone, shale); some rocks in this group have been formed by chemical deposition (e.g. some limestone). The remains of organisms such as marine shells or parts of plants that once lived in the waters and on the land where sediment accumulated can be found as fossils.

c) *Metamorphic rocks*, derived from earlier igneous or sedimentary rocks, but transformed from their original state by heat or pressure, so as to acquire conspicuous new characteristics (e.g. slate, schist, gneiss).

Rocks are made up of small crystalline units known as minerals and a rock can thus be defined as an assemblage of particular minerals, and named accordingly. For engineering purposes, however, the two terms 'rock' and 'soil' have also been adopted to define the mechanical characters of geological materials. 'Rock' is a hard material and 'soil' either a sediment which has not yet become rock-like, or a granular residue from rock that has completely weathered (called a residual soil). Neither of these terms is strictly adequate and descriptive qualifications are required to distinguish weak rocks from hard soils. Rocks and soils contain pores and fissures that may be filled either with liquid or with gas: e.g. water or air. Such voids may be very small but can make up a considerable proportion of a rock or soil mass.

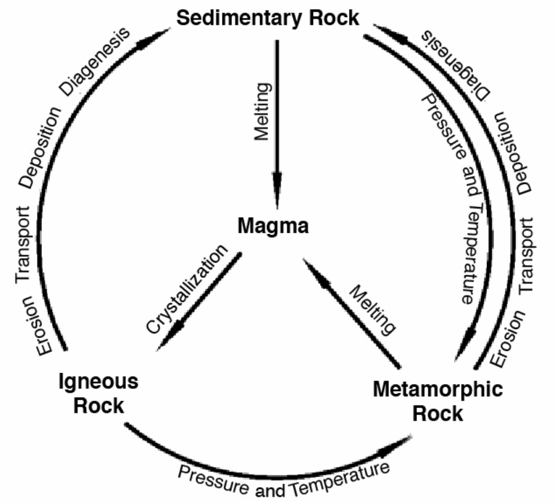

Figure 1. Three major types of rocks in a cycle.

1.2. Major division of the Earth

Appreciation of the origin of large features observed at Earth's surface (tectonics) requires information about the overall structure and composition of the Earth. Geophysical data gathered at the surface provide the bulk of observations on Earth's plate tectonic system and deeper regions.

a) *Classical (chemical) Divisions:* Earth's deep interior is known primarily from observations of the types and velocities of seismic waves traversing various regions; Earth's gravity field further constrains density distribution. The classical view of Earth's interior, developed in the early part of the 20th century, differentiated the Earth into three spheres according to density, the denser material concentrated toward the center (Figure 2). Drastic differences in density correspond to changes in chemical composition, defining the Crust, mantle and core.

b) *Modern (mechanical) Divisions:* The installation of more and better seismographs in the 1960's resulted in finer resolution of seismic wave velocities within the three spheres. A more modern division describes portions of the three spheres according to their physical state (hard solid, relatively soft solid, or liquid). Five zones thus recognized are the lithosphere, asthenosphere, lower mantle (or mesosphere), outer core, and inner core (Figure 2). The modern scheme simply describes the physical state of those chemicals under conditions of increasing temperature and pressure within the Earth. Silicates comprising the crust are generally so cold that they are rigid, forming the top part of the lithosphere. The iron/magnesium-rich silicates of the uppermost mantle are also relatively cold and rigid, forming the remainder of the lithosphere. At depths below about 150 km, those same mantle materials undergo slight partial melting, forming the softer asthenosphere. The pressure becomes so great below depths of 350 to 700 km that the lower mantle is a hard solid. The heavy (iron-rich) material of the outer core is liquid at the temperatures and pressures encountered between 2900 and 5100 km depth. The pressure is so great near Earth's center, however, that the same material exists as a solid inner core.

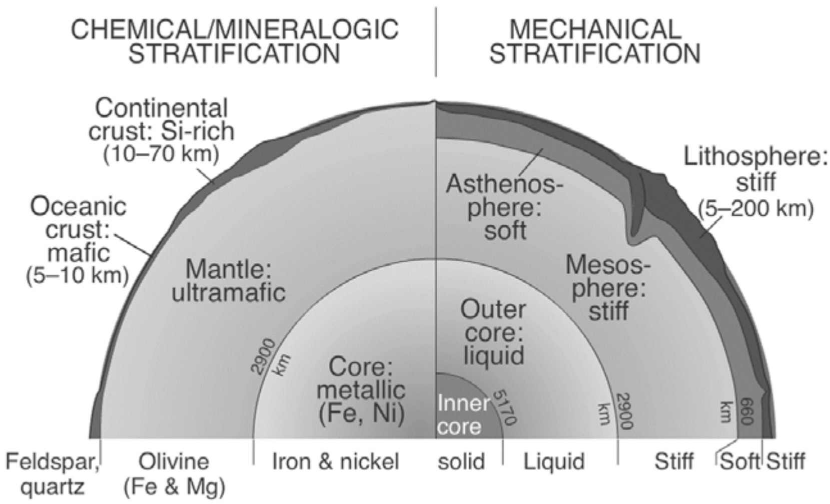

Figure 2. Classic and modern division of the Earth

1.3. Tectonic

While lying in a hospital room, recovering from wounds he received in World War I, Alfred Wegener (1880-1930), a German meteorologist and geologist, pondered the history of the Earth. He wondered why the eastern coastlines of North and South America looked like they could cuddle snugly against the western coastlines of Europe and Africa. Eventually, Wegener realized that all this and other phenomena made sense if, in the past, the continents fit together like pieces of a jigsaw puzzle into one "supercontinent", a vast landmass that he dubbed Pangaea.

In the 1960s, researchers from around the world rushed to explore the implications of the seafloor spreading hypothesis and to reexamine the phenomenon of continental drift. The result of this work led to a broad set of ideas, which together comprise the theory of plate tectonics (or simply "plate tectonics"). According to this theory, the lithosphere, Earth's relatively rigid outer shell, consists of discrete pieces, called lithosphere plates, or simply plates, which move relative to one another. Continental drift and seafloor spreading are manifestations of plate motion.

Plate tectonics is a geotectonic theory. It is a comprehensive set of ideas that explains the development of regional geologic features, such as the distinction between oceans and continents, the origin of mountain belts, and the distribution of earthquakes, volcanoes, and rock types. Geoscientists distinguish three types of plate boundaries (Figure 3a-d). (1) At divergent plate boundaries, defined by mid-ocean ridges (also called oceanic ridges, because not all occur in the middle of an ocean), two plates moveapart as a consequence of seafloor spreading. Thus, these boundaries are also called "spreading centers". (2) At convergent plate boundaries, one oceanic plate sinks into the mantle beneath an overriding plate, which can be either a continental or an oceanic plate. During this process, which is called subduction, an existing oceanic plate gradually disappears. Thus, convergent plate boundaries are also called "destructive boundaries" or "consuming boundaries". "Arcs" are so named because many, though not all, are curved in map view. The actual plate boundary at a convergent boundary is delineated by a deep ocean trench. (3) At transform plate boundaries, one plate slides past another along a strike-slip fault. Since no new plate is created and no old plate is consumed along a transform, such a boundary can also be called a "conservative boundary." Transform plate boundaries can occur either in continental or oceanic lithosphere.

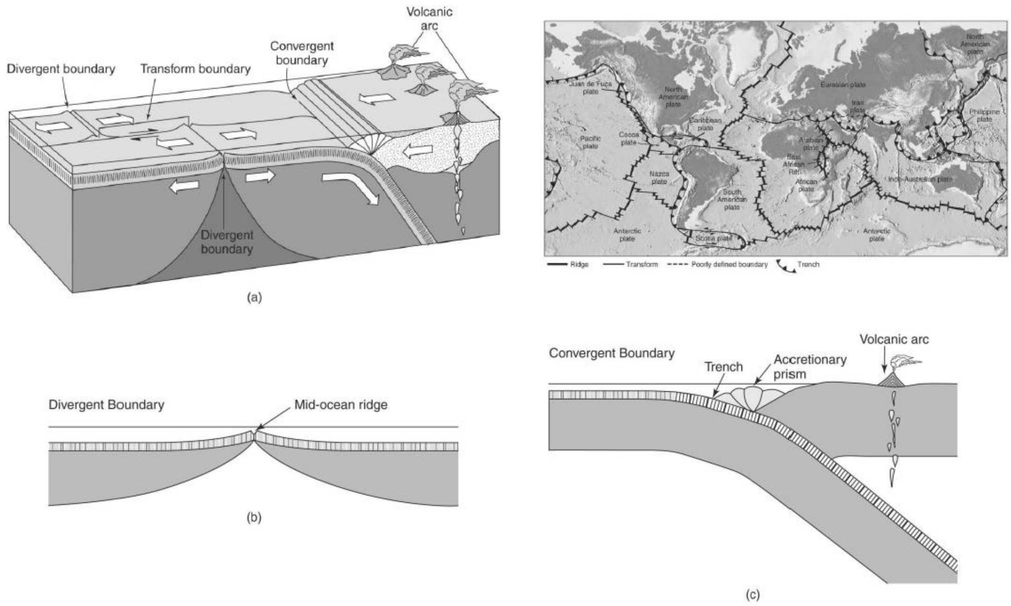

Figure 3. Plate tectonic boundaries.

Choose the best choice:

1. The Earth is a ……. body constantly subjecting to changes both at its surface and at deeper levels.

   A. Static B. Dynamic C. Solid D. Mass

2. Which change is not originate from interior parts of the earth?

   A. Movement of continents B. Volcanos

   C. Erosion D. Earthquakes

3. Limestone is a(n) …….

   A. Igneous rock B. Sedimentary rock

   C. Metamorphic rock D. Soil

4. For engineering purposes, rock and soil differ in ……..

   A. Chemical properties B. Composition

   C. Mechanical properties D. Grain size

5. According to classical model, which is the denser material?

   A. Crust B. Oceanic plates C. Mantel D. Core

6. ……. is consisted of crust and upper most mantel in modern division point of view.

   A. Lithosphere B. Asthenosphere C. Mesosphere D. Core

7. Modern division of the earth is based on …….

   A. Density B. Velocity of seismic waves

   C. Composition D. Physical state of material

8. The supercontinent introduced by Wagener was …….

   A. North and South America B. Eurasia

   C. Pangaea D. Africa

9. Mid-ocean ridges are … boundaries.

   A. Divergent B. Convergent C. Transform D. None of them

10. Which plate boundary is conservative?

    A. Divergent B. Convergent C. Transform D. None of them

Close test (Rock cycle)

There are three major types of rock: igneous, sedimentary, and metamorphic. The rock cycle is an important concept in geology which illustrates the relationships between these three types of rock, and magma. When a rock crystallizes from melt (magma and/or lava), it is a(n) …1… rock. This rock can be weathered and eroded, and then re-deposited and lithified into a …2… rock, or be turned into a …3… rock due to heat and pressure that change the mineral content of the rock which gives it a characteristic fabric. The sedimentary rock can then be subsequently turned into a metamorphic rock due to heat and pressure and is then weathered, eroded, deposited, and lithified, ultimately becoming a …4… rock. Sedimentary rock may also be re-eroded and re-deposited, and metamorphic rock may also undergo additional metamorphism. All three types of rocks may be re-melted; when this happens, a new …5… is formed, from which an igneous rock may once again crystallize.

1. A. Igneous B. Crystallized C. Sedimentary D. Metamorphic
2. A. Igneous B. Crystallized C. Sedimentary D. Metamorphic
3. A. Igneous B. Crystallized C. Sedimentary D. Metamorphic
4. A. Igneous B. Crystallized C. Sedimentary D. Metamorphic
5. A. Soil B. Rock C. Magma D. Deposit

Technical words:

Arcs	کمان	Marine	دریایی
Basin	حوضه - حوضهٔ رسوبی	Mass	توده سنگ
Bore	گمانه	Melt	مذاب
Coastal cliffs	صخره‌های ساحلی	Metamorphic rock	سنگ دگرگونی
Coastline	خط ساحلی	Meteorologist	هواشناس
Conservative boundary	مرز محافظ	Mid-ocean ridges	پشته‌های میان‌اقیانوسی
Consuming boundary	مرز مخرب	Mineral	کانی
Continent	قاره	Modeling	مدل‌سازی
Continental drift	اشتقاق قاره‌ای	Mountain belts	کمربند کوهستانی

Convergent boundary	مرز همگرا	Ocean	اقیانوس
Core	هستهٔ زمین	Ocean trench	گودال اقیانوسی
Crust	پوستهٔ زمین	Overriding plate	صفحهٔ بالارونده
Deep	عمیق	Partial melting	ذوب بخشی
Density	چگالی - وزن مخصوص	Phenomena	پدیده
Deposition	ته‌نشست - رسوب‌گذاری	Plate tectonics	تکتونیک صفحه‌ای
Destructive boundary	مرز مخرب	Pore	منفذ- خلل و فرج
Divergent boundary	مرز واگرا	Process	فرایند - پردازش
Dominant	غالب	Region	ناحیه- منطقه
Earth	زمین	Rigid	سخت- سفت
Earthquake	زلزله	Rock	سنگ
Erosion	فرسایش	Rock cycle	چرخهٔ سنگ
Fabric	ساخت - بافت	Sandstone	ماسه‌سنگ
Feature	عارضه- پدیده	Seafloor spreading	گسترش کف اقیانوس
Fissure	تَرَک- درزه - رگه	Sedimentary rock	سنگ رسوبی
Fossil	فسیل - سنگواره	Seismic waves	امواج لرزه‌ای
Geological time	زمان زمین‌شناسی	Seismograph	(لرزه) زلزله‌نگار
Geologist	زمین‌شناس	Soil	خاک
Geology	زمین‌شناسی	Spreading centers	مراکز جدایش
Geophysical data	داده‌های ژئوفیزیکی	Static	ایستا - ساکن
Glob	جهان	Strike-slip fault	گسل امتدادلغز
Granular	دانه‌ای	Structure	ساختار - ساخت
Gravity field	میدان ثقل (گراویته)	Subduction	فرورانش
Heat	گرما	Supercontinent	ابَر قاره
Igneous rock	سنگ آذرین	Surface	سطح
Inland	(در- درون) خشکی	Temperature	دما
Lava	گدازه - مواد مذاب	Void	حفره- پوکی
Limestone	سنگ آهک	Volcanic eruption	انفجار آتشفشانی
Lithify	سنگی شدن	Volcano	آتشفشان
Lithosphere plates	صفحات لیتوسفری	Weathered	هوازده
Mantle	گوشتهٔ زمین		

Answer sheet

1	2	3	4	5	6	7	8	9	10
B	C	B	C	D	A	D	C	A	C
1	2	3	4	5					
A	C	D	C	C					

Select reading (*Philip Kearey, Keith A. Klepeis, Frederick J. Vine, 2009.* ***Global Tectonics****, Blackwell Publishing, P 482).*

THE INTERIOR OF THE EARTH

1. The crust

1.1. The continental crust

Only the uppermost part of the crust is available for direct sampling at the surface or from boreholes. At greater depths within the crust, virtually all information about its composition and structure is indirect. Geologic studies of high grade metamorphic rocks that once resided at depths of 20–50 km and have been brought to the surface by subsequent tectonic activity provide some useful information. Foreign rock fragments, or xenoliths, that are carried from great depths to the Earth's surface by fast rising magmas also provide samples of deep crustal material. In addition, much information about the crust has been derived from knowledge of the variation of seismic velocities with depth and how these correspond to experimental determinations of velocities measured over ranges of temperature and pressure consistent with crustal conditions. Pressure increases with depth at a rate of about 30 MPa km^{-1}, mainly due to the lithostatic confining pressure of the overlying rocks, but also, in some regions, with a contribution from tectonic forces. Temperature increases