

Volcanoes, Volcanic Rocks and Earthquakes

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VOLCANOES, VOLCANIC ROCKS AND EARTHQUAKES A BIBLICAL VIEW



Patrick Nurre

The Northwest Treasures Curriculum Project
Building Faith for a Lifetime of Faith

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How to Use This Study

When it comes to studying Earth history and geology, it is vitally important that we help our students to develop a sound perspective about how this all relates to the Bible and especially to the Great Flood of Noah's time. That is the thrust of the *Northwest Treasures Curriculum Project*, of which this study is one component. ***Bedrock Geology***, which is the heart of this program, helps to set the stage for studying all the varying components of geology, and is a great pre-study for this one. *Volcanoes, Volcanic Rocks and Earthquakes* can, however, stand as a study on its own.

Suggestions for use:

1. This study takes about a semester. A suggestion would be to do this study 3-4 days each week: Day 1, define the *Words to know*, and read the lesson. The words may not be defined in the text. You will need to look up some of them. Day 2, reread lesson, highlighting important concepts. Days 3-4, do activities, and take the quiz.
2. Keep a notebook that has a separate section for vocabulary. Each section of the study has words that are vital to understand. If you encounter other geological terms that you don't know, be sure to include them as well.
3. If it is possible, try to get out into the field to find examples of the rocks you are examining. If you live near a volcanic area, take time for a field trip to research it.

Materials

This study is best used with rock and mineral samples, available from Northwest Treasures (at NorthwestRockAndFossil.com). Samples include:

- Quartz – rock-forming mineral
- Muscovite – rock-forming mineral
- Potassium feldspar – rock-forming mineral
- Sodium feldspar – rock-forming mineral
- Jasper – rock-forming mineral
- Calcite – rock-forming mineral
- Olivine – rock-forming mineral
- Biotite mica – rock-forming mineral
- Magnetite (iron ore) – rock-forming mineral
- Calcium feldspar – rock-forming mineral
- Amphibole – rock-forming mineral
- Pyroxene – rock-forming mineral
- Cinders
- Laccolith magma
- Basalt
- Vesicular basalt
- Pahoehoe
- A'a
- Scoria
- Dark pumice
- Ash
- Tuff
- Amygdaloidal basalt
- Olivine in basalt
- Oxidized basalt
- Basalt porphyry
- Rhyolite
- Perlite
- Light colored pumice
- Obsidian
- Andesite
- Dacite
- Vitrophyre
- Fault gouge

Lesson One – What are Volcanoes?



Mt. Fuji

*Words to Know: volcano fissure uniformitarianism volcanic rock interpretation
worldview catastrophic magma The Age of Enlightenment (the Enlightenment)
accountable mythological the rock cycle*

Introduction

One of the confusing things about developing a Biblical view of Earth history is the nomenclature or language of science. For instance, the word **volcano** is not mentioned in the Bible. Ever since the **Enlightenment** (1700s-1800s) the science community has adopted the language of the Greeks and Romans – Greek and Latin. The Old Testament, written in Hebrew, was written before this adoption and the New Testament was written in Greek that is slightly different from Modern Greek. The modern student rarely studies Greek or Latin and so the language of modern geology can be intimidating and can seem secretive. Consequently, the student of science Bible must learn a new language in order to comprehend modern geology and its relationship to the Bible.

The word **geology** comes from two Greek roots, *geo*, the earth, and *logi*, the study of – the study of the earth. This subject is huge, and it includes the following:

- a) The study of the present geologic forces and processes that are now at work on the earth
- b) The study of the rocks and minerals that are a part of these forces
- c) The study of the landforms on the earth, of which volcanoes would be a part
- d) The study of Earth History

What is a Volcano?

The word **volcano** comes from the name of a **mythological** god named Vulcan – the god of fire. And that does aptly illustrate the nature of volcanoes – explosions of fire and hot steam, rock, ash, and lava. But from a Scriptural viewpoint, volcanoes illustrate something much more. Volcanoes are extremely destructive geologic events. In addition to the blast and destructive rolling clouds of bits and pieces of **volcanic rock** and very hot steam and ash, there are all kinds of poisonous gasses that are emitted during an eruption. Rolling lava flows can destroy property and life very quickly.

So, volcanoes are **fissures** or openings in the earth that release destructive forces to man and his environment.

Volcanoes are actually weaknesses in the earth left over from another time in Earth history. In Genesis chapter 1:31, the Scripture states, “God saw all that He had made, and behold, it was very good. And there was evening and there was morning, the sixth day.” How would volcanoes fit into this view of the finished creation?

Discuss: From a Scriptural viewpoint, how could these volcanic menaces be part of the “very good” earth talked about in Genesis chapter one?

History and Worldview

Before we get into the study of volcanoes, we need to clear up a misunderstanding that continues to this day and is taught by both science and some churches. Our public institutions continue to teach that in the debate about origins and Earth history, the issue is *Science vs. Religion or Science vs. the Bible*. This is a huge distortion of the truth. The true issue since the Enlightenment has always been, *Science plus philosophy vs. Science plus the Scriptures*. In our study of geology and in particular, volcanoes, it will be necessary to constantly distinguish between these two conflicting **worldviews**. The word *science* comes from a Latin word meaning, knowledge. It is not in the area of knowledge where the Scriptures conflict with modern geology, but in the area of worldview; the conflict comes in the **interpretation** (worldview) of the knowledge we gain by studying the earth.



In the late 1700s the Father of Modern Geology, James Hutton, a Scottish physician, taught that according to his observations of geologic processes that he witnessed, that he “...could find no vestige of a beginning, no prospect of an end.”¹ In other words, the geological formations we see around us have been always changing so that we can’t properly see how they started, and this process will continue as long as the earth exists. He came to this conclusion because he assumed that these geologic processes had always operated at the pace he presently observed. He reasoned that the earth must be older, much older than what the Bible stated.

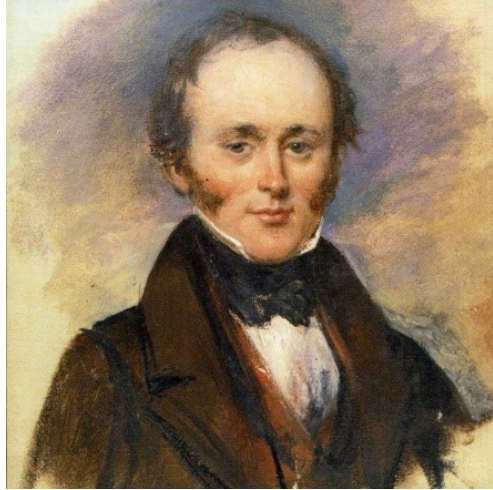
This was the beginning of an idea called **uniformitarianism** – *present geologic processes are sufficient to explain the past operations of the earth*. Consequently, no god or **catastrophes** like

Noah’s Flood were needed to explain the past history of the earth and indeed, according to Hutton,

¹ *Theory of the Earth; or an Investigation of the Laws observable in the Composition, Dissolution, and Restoration of Land upon the Globe* and appeared in *Transactions of the Royal Society of Edinburgh*, vol. I, Part II, pp. 209–304, plates I and II, published 1788.

no god should be allowed into the realm of science to explain such natural phenomenon. This sums up the Enlightenment period in Western Civilization – a time of drifting from the church, God and the Scriptures.

In the 1830s another man named Charles Lyell, a British Lawyer, popularized Hutton's ideas in a phrase that is still used today: *"The present is the key to the past."* And so, modern geology has continued to this day to view the past history of the earth in terms of present observable processes.



Here is an example – today we observe an abundance of **volcanic rocks** all over the earth. Some layers of these volcanic rocks exceed more than a mile in thickness. Modern geology would interpret these layers as evidence that the origin of the earth was begun in volcanic eruptions and then slowly changed over millions of years into the soils and landscapes we see today. A Scriptural viewpoint would interpret these layers as a result of the Genesis catastrophic Flood and its aftermath. Why the conflict? Is

it because the Bible teaches scientific error? There is nothing in the science of the volcanic rocks that would tell us that they are millions and billions of years old. But it is the worldview, the interpretation, that would determine this. (We will discuss more about this in **Lesson Six**.)

In Genesis 7:11 we read, *"In the six hundredth year of Noah's life, in the second month, on the seventeenth day of the month, on the same day all the fountains of the great deep burst open, and the floodgates of the sky were opened."* This historical account records the horrendous geologic events of the first day of the Genesis Flood – *"...the fountains of the great deep burst open...."* This event would certainly imply that there must have been fissures opened in the earth through which came an abundance of water and **magma**.

So the volcanic rocks which cover the earth were the result of the different stages of the Genesis Flood and its catastrophic upheaval. Volcanic eruptions continue to this day, but with much less frequency and intensity. Volcanoes are ruptures; weaknesses in a once very good Earth. Volcanic eruptions serve as a reminder that God held man **accountable** for his moral choices and that there will be a day in the future when He will once again hold man accountable.

The origin of volcanoes as interpreted from a Biblical viewpoint is not some mythological story to explain the wrath and anger of the gods, but a real historical event brought on by God as a consequence of man's rebellion against his creator. Ever since the Enlightenment, the Scriptural history of the global Flood of Noah's day has been relegated to the domain of myth. The idea of God's involvement in His creation has been called nonsense by secularists. If the Genesis Flood was indeed a consequence of man's rebellion, then man must recognize a God Who rules over all, and that calls man into accountability for his actions.

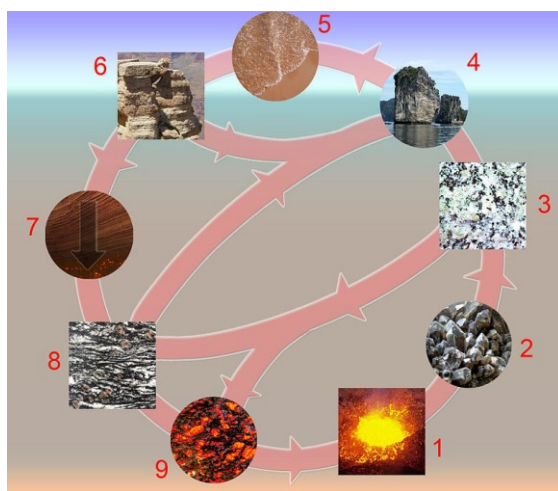
Memorize: Genesis 7:11

The Rock Cycle

James Hutton viewed the history of the earth in a cyclical way. He saw the geologic history of the earth as sort of giant recycling process, constantly reusing the materials of the earth to generate new crust, rocks, and change in existing landforms. Volcanoes represented part of this ongoing history. Of course, if we did not have Biblical revelation to tell us about the origin of the earth and other significant geologic events like the global Flood, then it might be reasonable to ponder explanations like Hutton's. But we do have these historical events recorded and authenticated by Jesus in the New Testament (Matthew 24:37-39, Matthew 19:4). To ignore them would truly lead to a blindness of God's involvement in His creation.

Today, Hutton's views have been expressed in a popular diagram called the **rock cycle**. What is the rock cycle? It is a diagram taught as pure science by our public institutions and many private and Christian schools. It portrays the idea that the earth's rocks recycle. That is, rocks are constantly being reproduced in the Earth's mantle and core, eroded and changed by erosive and metamorphic process to be used again and again – a sort of giant recycling machine. No wonder Hutton said he could see no vestiges of a beginning nor prospect of an end! Is this representation true?

Study the typical illustrations of the rock cycle below and record what you observe. Do you think these processes are always true? When might they have been different? Have these processes been observed?



A diagram of the rock cycle. Legend: 1. magma; 2. crystallization (freezing of rock); 3. igneous rocks; 4. erosion; 5. sedimentation; 6. sediments and sedimentary rocks; 7. tectonic burial and metamorphism; 8. metamorphic rocks; 9. melting.

Now, there is no doubt that some of these processes might occur under certain circumstances. But geologists teach these processes as if they were totally true. They also teach them as processes that were slow and gradual over hundreds of millions of years. But to say that these processes represent all of Earth history is an assumption that cannot be scientifically proven. If the geologic events described in Genesis are historical events, then processes would have been totally different during these particular events. The Genesis Flood describes an event that involved rapid erosion, rapid deposition, rapid transportation, and rapid rock formation. So, what is the science in volcanoes and volcanic eruptions and how does the Bible explain such horrific events? We'll look at the answer to this question in the next section.

Activity #1

Charting the History of the Enlightenment and its Influence on the Rejection of a Biblical View of Earth History

Research the historical period called the Enlightenment. Record the main thinkers and events that led up to a rejection of the Biblical view of the Genesis Flood. Construct a chart that illustrates these events from the 18th through the 19th centuries. Ideas for investigation might include influential thinkers, the French Revolution, the American Revolution, Darwin's journey on the Beagle, etc.

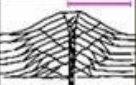
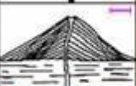
Take Quiz 1 (back of book).

Lesson Two – Types of Volcanoes

Words to know: *fissure volcano shield volcano dome volcano cinder cone composite volcano stratovolcano caldera scoria volcanic vent basalt butte Ring of Fire oceanic trench rift laccolith planation surface intrusion sheet erosion channelized erosion*

Types of Volcanoes

Not all volcanoes are alike. Learning the various features of the different volcanoes will help you identify different volcanic rocks in a later section. Let's take a look at some of the various types of volcanoes. (Although different types of volcanic rocks are necessarily mentioned in this lesson, we will wait until a later lesson to discuss them.)

Types of Volcanoes			
Volcano Type	Characteristics	Examples	Simplified Diagram
Flood or Plateau Basalt	Very liquid lava; flows very widespread; emitted from fractures	Columbia River Plateau	
Shield Volcano	Liquid lava emitted from a central vent; large; sometimes has a collapse caldera	Larch Mountain, Mount Sylvania, Highland Butte, Hawaiian volcanoes	
Cinder Cone	Explosive liquid lava; small; emitted from a central vent; if continued long enough, may build up a shield volcano	Mount Tabor, Mount Zion, Chamberlain Hill, Pilot Butte, Lava Butte, Craters of the Moon	
Composite or Stratovolcano	More viscous lavas; much explosive (pyroclastic) debris; large; emitted from a central vent	Mount Baker, Mount Rainier, Mount St. Helens, Mount Hood, Mount Shasta	
Volcanic Dome	Very viscous lava; relatively small; can be explosive; commonly occurs adjacent to craters of composite volcanoes	Novarupta, Mount St. Helens Lava Dome, Mount Lassen, Shastina, Mono Craters	
Caldera	Very large composite volcano collapsed after an explosive period; frequently associated with plug domes	Crater Lake, Newberry, Kilauea, Long Valley, Medicine Lake, Yellowstone	



Topinka, USGS/CVO, 1997, Modified from Allen, 1975, Volcanoes of the Portland Area, Oregon, Ore-Bull, v.37, no.9

Fissure volcanoes (also called flood or plateau **basalt** flows); These are vents, or **riffs** through which

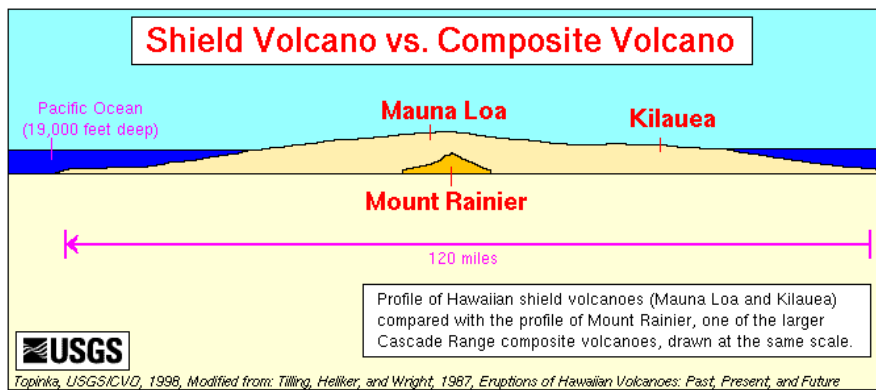


lava erupts, usually without any explosive activity. Fissure vents can cause large basalt floods (or flows) and lava channels. This type of volcano is usually hard to recognize from the ground and from outer space because it has no central crater or opening, and the surface is mostly flat. The volcano can usually be seen as a crack in the ground or on the ocean floor. An example of a basalt flood as a result of a fissure volcano would be the Columbia River Plateau.

Shield volcanoes look like a huge shield, convex side up. The lava comes through a central vent. Shield volcanoes usually stretch for miles and are not easily visible close up. Shield volcanoes are built almost entirely of fluid basalt lava flows. Examples would be the Hawaiian volcanoes, Mauna Kea and Mauna Loa.



Mauna Loa is a shield volcano on the Big Island of Hawaii.



Mauna Loa is the earth's largest shield volcano.

Ash or cinder cones usually erupt just once in their life cycle. Another name for a cinder cone is **scoria cone** because the type of lava it erupts is the volcanic rock scoria, which is airy, lightweight, basaltic lava. The lava is explosive and liquid, emitted through a central vent. Examples include Craters of the Moon, SP Crater, and Lava Butte.



Craters of the Moon, Idaho; SP Crater in the San Francisco volcanic field of Arizona is an example of an ash/cinder cone volcano.



This cinder cone is located on Mauna Kea shield volcano, Hawaii.

Composite or stratovolcanoes build high cones made of repeated volcanic eruptions and lava flows. These lavas are more viscous and explosive and have a large central vent. These can build up very quickly. Examples include Mt. Fuji, Mount Rainier, Mt. Hood, and Mt. St. Helens. Mt. St. Helens is both a dome and a stratovolcano.



Mt. Fuji is a composite or stratovolcano; Mt. Hood is a composite or stratovolcano.

Dome volcanoes often form inside of the craters of existing composite or stratovolcanoes, or adjacent to the volcano. Their lava is very viscous, rhyolite or dacite lava. They tend to be smaller volcanoes. Examples would include the Mt. St. Helens Dome, Shastina, and Chaitén.



Chaitén, near the Gulf of Corcovado in southern Chile, South America, is a dome volcano.

Lesson Three – Types of Volcanic Rocks

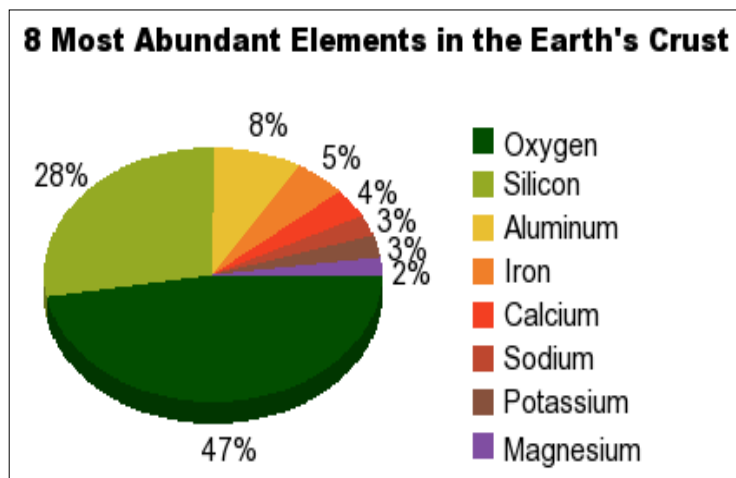
Words to know: element mineral rock mafic felsic fine-grained rhyolite andesite dacite phenocryst pyroclastic tephra tuff pahoehoe A'a

Types of Volcanic Rocks

In order to understand and identify volcanic rocks, we will have to learn about what is in them. What makes them black? What makes them gray or pink? Why are some of them filled with holes? Why do some of the volcanic rocks polish to a brilliant shine and others remain dull? Volcanoes don't just erupt black lava, but also a variety of dark and light-colored lavas, some that are very beautiful. All these questions can be answered by studying the minerals that are contained in the volcanic rocks.

The Minerals

Let's start at the beginning and discuss what rocks are made of. **Rocks** are made of **minerals**. But even smaller yet, minerals are made of **elements**. So, we have to talk about which elements are significant to our discussion.



The earth is an amazing place! It is uniquely fitted for life. That shouldn't surprise us. After all, "In the beginning God created the space and the earth." Let's talk about the most abundant elements in God's creation. This chart tells us that out of all the elements (over 90 natural elements), there are eight that form most of the earth's crust and consequently the rocks that comprise the earth's crust. These eight elements make up the minerals. Combinations of these various

minerals make up all of the rocks. (Other minerals may be present in the rocks, but these are the primary ones.) On a very interesting note, if you change any one of these elements such that you decrease or increase the percentages, you will change the nature of our earth. God has given us just the right elements in the right percentages to make life possible. You will also notice that these elements are vital for our own health and are found in the foods we eat. *You will need to learn these elements.*

That means that normally you cannot see the mineral makeup with the naked eye, only a general color. The colors are due to the minerals that they contain. So, we will begin with the minerals that make up the volcanic rocks – the rock-forming minerals.

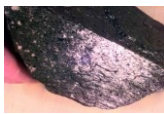
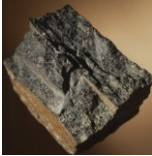
Learning the Chemical Symbols for the Most Abundant Elements

- | Elements | |
|---------------|----|
| • Oxygen - | O |
| • Silicon - | Si |
| • Aluminum - | Al |
| • Iron - | Fe |
| • Calcium - | Ca |
| • Sodium - | Na |
| • Potassium - | K |
| • Magnesium - | Mg |

The Rock-Forming Minerals

Even though there are over 4,000 identified minerals today, you only need to know just a few of them in order to understand and identify volcanic rocks.

The Mafic (magnesium and iron) Minerals – the Darker Minerals

 Amphibole (Ca,Na)₂- 3(Mg,Fe,Al)₃(Al,Si)₈ O₂₂(OH,F)₂	 Pyroxene (Ca,Na)(Mg,Fe,Al, Ti)(Si,Al)₂O₆	 Calcium Feldspar (Ca,Na)(Si,Al)₄O₈	 Biotite Mica K(Mg, Fe⁺⁺)₃ [AlSi₃O₁₀(OH,F)₂	 Iron Fe	 Olivine (Mg, Fe)₂SiO₄
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The Felsic Minerals (feldspar and silica (quartz)) – the Lighter Minerals

 Quartz SiO₂	 Muscovite Mica KAl₂(Si₃Al)O₁₀(OH,F)₂	 Potassium Feldspar KAlSi₃O₈	 Sodium Feldspar NaAlSi₃O₈	Sedimentary Mineral  Calcite CaCO₃	Sedimentary Mineral  White Calcite CaCO₃
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Notice that all these minerals are made of the eight most abundant elements, combined in a special way to produce specific minerals. We call these minerals, **the rock-forming minerals** because they form most of the rocks on Earth. The rock-forming mineral calcite is mainly found in sedimentary rocks. When it is found on volcanic rocks, it is called caliche. It is found primarily on volcanic rocks from arid regions. Why this occurs is not totally understood.

It is these minerals that give lavas their characteristic colors. Here is a rule of thumb to remember when trying to identify volcanic rocks – the darker colored minerals make up the darker colored volcanic rocks and the lighter colored minerals make up the lighter colored volcanic rocks.

The main thing you need to know about identifying volcanic rocks is that they are all **fine-grained** rocks. That is, their individual mineral crystals cannot generally be seen with the naked eye, only a general color. From the list below, you will notice that volcanic rocks can be dark colored, very light colored, or in between. These shades of color are due to the rock-forming minerals.

The Darker Colored Volcanic Rocks

The Basalt Family – basalt is a mafic volcanic rock made up of the darker colored minerals from your chart above. It has very little quartz and is quite common. It characterizes the lava flows of Hawaii and of the Columbia Basalt Flows.

- a) Aphanitic basalt (plain black or gray lava): it can be used as building material. In the pictures below, it was used for a pillar and for building a wall both found at Capernaum, Israel).



- b) Vesicular basalt (basalt with gas vesicles)



- c) Basalt breccia (angular pieces of volcanic rock in a petrified mud matrix; samples from Yellowstone volcanic mudflows)



- d) **Pahoehoe** basalt (ropy lava, found on the Big Island of Hawaii)



- e) **A'a** basalt (sharp, spiky lava, found on the Big Island of Hawaii)



- f) Scoria (frothy basalt from Hawaii, and El Malpais in New Mexico)



- g) Cinders (erupted small particles, like popcorn, from Craters of the Moon in Idaho)



- h) Bombs (basalt lava thrown through the air during eruptions, from El Malpais in New Mexico)



- i) Amygdaloidal basalt (vesicular basalt with crystals in the gas pockets found in Oregon)

