石油教材出版基金资助项目

石油高等院校特色教材

A Primer of Petroleum Engineering English

石油工程专业英语教程

聂翠平　刘贵喜　编著

石油工业出版社
Petroleum Industry Press

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内容提要

本书在内容选题和编排上较好地结合了石油工程专业英语的教学要求和技术发展，在注重石油工程专业基础知识的基础上，突出了工程应用技术，广泛涉猎了当今石油工程前沿技术。书中的翻译练习精选了课文里较少系统涉及的相关石油工程常识基础，附录中给出了英文释义的基础专业术语。通过本教程的学习，能强化石油工程专业人员的英文科技文献阅读能力。

本书可供相关专业本科、研究生进行石油工程专业英语阅读学习，也可供油田现场石油工程技术人员培训、学习时参考。

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前　言
Preface

本教程为石油工程专业英语教材，全书内容分为三大部分：第一部分为石油工程专业英语基础，内容涵盖了油气组成及其性质、石油地质、石油勘探原理、钻井与完井工程、采油工程；第二部分为现代石油工程应用技术专题，内容涵盖了定向钻井技术、复杂结构井应用基础、分支井技术、MWD/LWD 和地质导向技术应用、人工举升技术、地层出砂与防砂原理、常用增产措施原理、控水采油技术原理、油藏模拟；第三部分为泛读材料，涉及专项应用技术和石油工程新兴前沿技术，内容涵盖钻井液技术、固井水泥浆技术、试井技术、欠平衡与控制压力钻井技术、膨胀管技术、套管钻井技术、智能完井技术、连续油管及其应用、系列 EOR 技术。

英译汉翻译练习精选了课文中较少系统涉及的相关石油工程常识基础，附录为英文释义基础专业术语。

相比于已有教材，本教程系统性较好、专业技术涵盖面广，在注重石油工程专业基本知识的基础上，突出了工程应用技术，广泛涉猎了当今石油工程前沿技术，旨在通过本教程的学习强化相关石油工程英文科技文献的阅读能力，奠定轻松应用英文网络资源、从容应对国际学术交流和石油工程国际合作的专业英语基础，进而具备一定的英文科技写作能力。

本教程可作为相关专业本科和研究生石油工程专业英语阅读教材，也可供油田现场石油工程专业技术人员培训、学习时参考。

本教程由聂翠平主编，叶登胜负责编写了其中的 1－1、1－2、1－3、2－4 四节，刘贵喜编写了第三部分前五节，其余部分由聂翠平编写。

本教程编撰过程中参考、引用了较多方面的资料，是在精选内容、系统整理的基础上编撰而成。特此向有关公司和个人致谢。

聂翠平

2009 年 2 月

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Part A Petroleum Engineering Fundamentals

1 – 1 Petroleum

Petroleum is a substance, usually liquid or gas, consisting of organic molecules composed of hydrogen and carbon atoms. Thus the general name "hydrocarbons" is often used. The possible variations in the construction of the molecules and mixtures of different molecules to form naturally occurring oil (crude oil) are virtually limitless. No two crude oils are identical. Because these complex mixtures of organic matter are found in rock, they are called "petroleum", a word derived from the Latin words for rock (petra) and for oil (oleum).

We usually believe that Most petroleum is formed from organic matter, tiny particles of plant and animal debris that accumulated with mud deposited in stagnant bodies of water[1]. The original organic material was mostly microscopic marine plants and animals that lived in open seas[2], but much of it may have been derived from land plants and carried by streams to the site of deposition. Despite stories you might have heard, dinosaurs did not contribute to the original soup. Organic material is easily destroyed by exposure to air. Deposition of the material must be rapid in waters containing little or no oxygen due to water stagnation. Where water is oxygen deficient and chemical reactions take oxygen atoms away from molecules it is said to be a "reducing" condition[3], a requirement for the preservation of organic matter. Also, low-oxygen environments greatly decrease the number of scavengers that might otherwise consume and destroy the organic morsels. Usually the proper conditions occur in quiet marine basins, lagoons, and rapidly buried delta deposits, but similar conditions prevail in some lakes.

The beds of sedimentary rock in which the petroleum is formed are called the "source rocks". They are usually dark gray or black shales, but limestone is a source under some conditions. Shale has an abundance of pore space between the clay particles which can contain liquid, but the pores are much too tiny to allow the movement of fluids under normal conditions. In other words, shales are not "permeable". However, the pressure produced by the processes of petroleum generation expels the fluid, and petroleum has to move from the source rock at some stage of development to become economically producible. The event is called "primary migration". Once departed from the source bed, the oil or gas will enter any nearby porous and permeable rock, such as sandstone or limestone.

Oil and natural gas are less dense than water and, for all practical purposes[4], are insoluble in water. If the fluids are mixed, oil and gas rise to the surface of the water. Rocks beneath the water table are, by definition, saturated with water. Petroleum leaving the source rock enters a water-wet rock and must try to rise to the top of the porous layer. If the porous rock is also "permeable", that is, fluids can pass from one tiny pore to another or "flow" through these tiny channel ways in the rock, the petroleum will rise until it reaches impermeable rock above. Keep in mind that pores in most rocks consist of tiny spaces between the sand grains or crystals. The pores must be interconnected for fluids to pass from one pore to the next, and the connecting opening must be larger than a hydrocarbon globule for movement to occur. Such movement of petroleum after leaving the source rock is called "secondary migration".

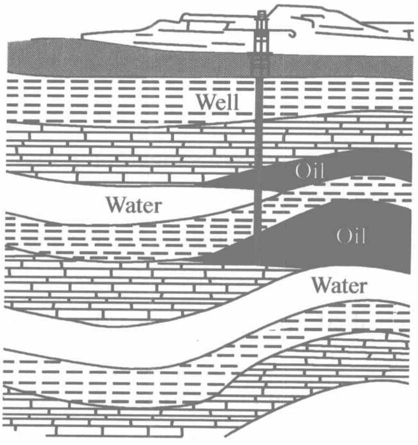

Fig. 1-1-1 Petroleum trapped at the anticline crest.

Threads and tiny globules of oil or bubbles of natural gas collect at the top of the porous-permeable rock layer as illustrated in fig. 1-1-1. Such accumulations are usually too small to be recovered practically from a well. However, if the rocks are tilted somehow, the petroleum will continue to migrate up the sloping top of the bed until it reaches the surface or an impermeable barrier to its flow. The measured inclination of a rock layer is said to be the "dip" of the rock. If the petroleum reaches the surface of the earth at an "outcrop" of the rock layer, it flows onto the surface as an oil or gas "seep"[5]. If the petroleum rises to an impermeable limit it is said to be trapped. An "oil trap" is any natural barrier to the up-dip migration of petroleum; and huge amounts of oil and/or natural gas may accumulate.

★课文注释:

[1] stagnant bodies of water 不流动的水体
[2] open seas 广海,又称"开阔海"
[3] "reducing" condition 还原环境
[4] for all practical purposes 实际上
[5] an oil or gas "seep" 油苗或气苗

★专业词汇:

anticline 背斜
basins 盆地
bed 地层,岩层
crude oil 原油
delta deposits 三角洲沉积
deposition 沉积
dip 倾斜
formation dip 地层倾角
impermeable 非渗透性的
inclination 倾斜
lagoon 潟湖

limestone 石灰岩
outcrop 出露层,露头
permeable 渗透性的
petroleum 石油
porous 孔隙的
primary migration 一次(初次)运移
sandstone 砂岩
secondary migration 二次运移
sedimentary rock 沉积岩
shale 页岩
trap 圈闭
water table 地下水位
water-wet 水湿性的

1-2 Geology of Petroleum

Sedimentary rocks

Petroleum may occur in any porous rock, but it is usually found in sedimentary rocks such as sandstone or limestone. Sedimentary rocks are grouped into three major classes: clastic, carbonate, and evaporitic.

Clastic rocks are those that are formed by the accumulation and cementation of sedimentary particles derived from weathered fragments[1] of preexisting rocks. Weathering processes, such as freezing and thawing, rain, wind, and other similar events, break down the parent rock into small particles that can then be transported by wind and rain runoff[2]. Streams carry the mud, sand, and gravel from the source area down to its final resting place, being that a stream channel, floodplain, lake, or ultimately the sea. There it accumulates, is buried and compacted by later-arriving sediments, and cemented to form sedimentary rocks. The mud compacts to shale or mudstone, the sands are cemented by silica or calcite to form sandstones, and the gravels become conglomerates. Sandstones, because of the inherent porosity between their grains, often become excellent reservoirs for oil or natural gas.

Carbonate rocks are limestones and dolomites. They usually form in warm seawater at shallow depths, ankle deep to about 6 m, where various plants and animals thrive. The hard, usually calcareous parts of the organisms pile up on the seafloor over time, forming beds of lime particles. Algae, simple plants, are one of the greatest contributors of lime particles, but any shelled animal may contribute whole or fragmented shells to the pile. Reefs, banks of lime mud, and lime sand bars are commonly found preserved in rocks.

Carbonate sediments are subject to many processes in becoming a rock. If lime mud is exposed to the air, it simply dries out and almost overnight becomes a natural "concrete", and lime sands become cemented by the evaporation of lime-rich seawater to form "beach rock".

Rainwater, however, begins to destroy the rock and forms porosity in the process. If not exposed to the air, lime sediments continue to accumulate, perhaps to great thicknesses. Under these conditions, they compact under the weight of new sediments and eventually are cemented to form limestone. These rocks are rarely porous unless other processes become involved.

Limestone is composed of calcium carbonate (calcite or aragonite), thus the general rock term "carbonate" is used. Magnesium, a common element in seawater, can replace some of the calcium within the crystal structure of calcite. This often happens by various processes that are not fully understood; the resulting rock is known as "dolomite" (calcium-magnesium carbonate). The process of changing limestone to dolomite produces somewhat smaller crystals, so the resulting rock has tiny pores between the new crystals. This kind of porosity, much like that in sandstone, often contains oil and natural gas.

Evaporite rocks are formed by the direct precipitation of minerals by evaporation of seawater. Resulting rocks are ordinary salt (halite-sodium chloride), gypsum (calcium sulfate with some water), and various forms of potash salts. When gypsum is buried to considerable depths, the water is expelled from the crystals and "anhydrite" (meaning simply "without water"), a harder crystalline rock, results. Evaporites are not porous, although they are readily dissolved by water and are not source rocks for petroleum. However, they may be formed in highly stagnant water where black mud, rich in organic matter, may also be deposited, and so are commonly associated with good source rocks. Because they are impermeable, evaporates often form seals on other reservoir rocks.

Layered rocks

Geologic time is nearly incomprehensible to the human mind. We usually think in terms of a few tens of years, since that measures a lifetime. Hundreds or thousands of years are considered ancient history. But in geology, we must think in time spans of millions of years, hundreds of millions of years, even of billions of years. Geologists measure such tremendous spans of geologic time in a relative sense[3], that is, one event occurred after another and prior to a third event. In that sense, a geologic time scale was developed in the 1800's to make handy "boxes" of relative time periods in order to think of events in an understandable manner. "Periods" and "eras" were named to designate varying intervals of time that then seemed to be useful[4].

The actual time in years, "absolute time" is more difficult to determine. Geologists are now able to calculate time from the decay rates of radioactive elements, such as uranium and potassium. Radioactive minerals are required for this exercise, and these only occur in certain rocks, usually igneous rocks such as granite. Thus sedimentary rocks can only be dated relative to the occurrence of related igneous events, usually with the aid of fossils that fit into evolutionary sequences. As one might guess, dates in years for sedimentary rocks are still relative, and uncertain at best.

There are many reasons to believe that the Earth formed about 4.5 billion years ago. However, it was not until the beginning of Cambrian time, about 545 million years ago, that sedimentary rocks containing fossils became abundant. The first four billion years of Earth history, lumped by geologists into the Precambrian Era, can only be dated where radioactive minerals are available.

Structure

Once formed, sedimentary rocks are subject to various kinds of deformation, such as folding and faulting. Three general types of folds are anticlines, synclines, and monoclines.

Folds

Three general types of folds are anticlines, synclines, and monoclines, as shown in fig. 1-2-1.

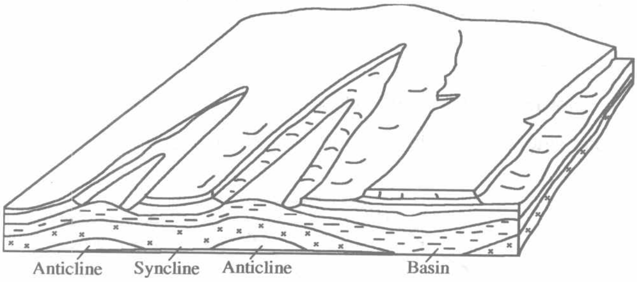

Fig. 1-2-1 Anticlines in Upfolds, synclines in downfolds, basins in broad downfolded area from layered formation fold.

Anticlines are upfolds in the layered rocks. They are usually long, high wrinkles in the rocks that may extend for hundreds of feet, but normally they are miles or tens of miles long and may have numerous prominences. Anticlines are much like the "up-wrinkles" produced in a rug or sheet of paper when pushed or squeezed from side to side and are formed in much the same way as the Earth's crust was compressed or shortened by lateral forces. Circular upfolds in the rocks are called "domes", as shown in fig. 1-2-2. Anticlines are important types of "structural traps" in petroleum geology, as petroleum migrating up the dip along a flank of the fold is trapped at the crest. It can't rise any farther up the tilted strata and can't go back down the other flank, at least until the fold is full of oil and/or gas.

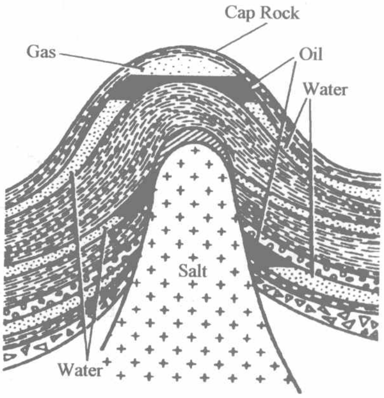

Fig. 1-2-2 Salt domes often deform overlying rocks to form traps.

Synclines are the opposite of anticlines. A syncline is a downfold, usually occurring between two anticlines. Synclines, like their associated structures the anticlines, are elongate, perhaps extending for many miles. More or less circular depressions in the layered rocks are called "basins", but that term is usually reserved for very large depressions, tens or hundreds of miles wide, in the Earth's crust. Such large basins are natural centers for thick accumulations of sedimentary rocks. Unlike anticlines, synclines only form structural traps for petroleum when the depressed strata occur above the water table in dry rocks and oil gathers in the bottom by gravity flow.

Faults

Faults are breaks, or fractures, in rocks along which one side has moved relative to the other side, as shown in fig. 1-2-3, 1-2-4 and 1-2-5.

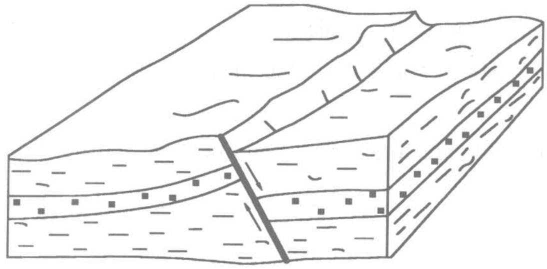

Fig. 1-2-3 Normal fault-fractures along which movement has taken place, one side dropped down by gravity relative to the other.

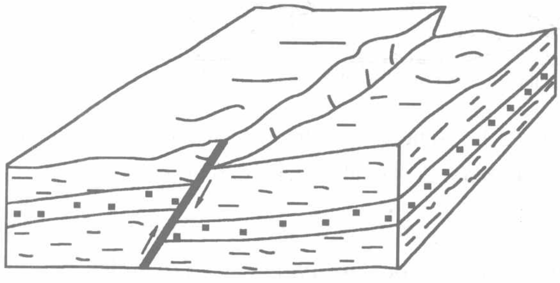

Fig. 1-2-4 Reverse fault-one side of the fracture is pushed up and over the opposite side along a steep fracture.

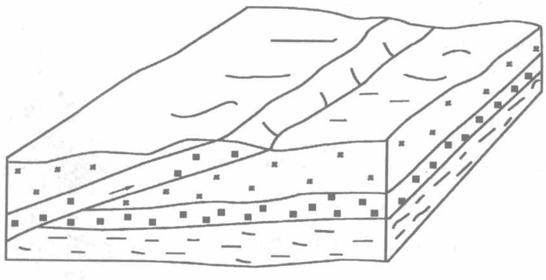

Fig. 1-2-5 Thrust fault-a sheet of rock in fractures is forced up and over the opposite side of the fault along a low-angle break.

There are many kinds of faults, some of which are important as structural traps for petroleum.

Faulting, for example, is important to entrapment and migration of oil. The most common type of fault is the "normal fault". In this case, rocks along one side of the break simply drop down relative to the other side. This happens when the Earth's crust is stretched.

Another kind of fault occurs when one block of rock is faulted upward and over another. If the plane of the fault is steep, it is called a "reverse fault" and if it is low angle, it is called a "thrust fault". Reverse and thrust faults occur when the Earth's crust is compressed, or shortened. When this occurs, folds usually form first, only to break into thrust faults when the strength of the strata involved is exceeded by the compressional forces.

Fractures in otherwise tight, nonporous rocks can themselves be open, providing "fracture porosity" that may contain petroleum. Thus a shale or dense limestone may be fractured and contain oil, forming another type of structural trap. Fractures commonly break through porous rocks and increase the permeability greatly by providing pathways that interconnect rock pores.

As we have seen, different types of sediments eventually produce different porosity/permeability relationships in the rocks. If the rock type varies due to water depth that is controlled by structural movement during deposition, local variations in porosity/permeability will result. Thus a definite relationship exists between geologic structure and the kind of sedimentary rock that is produced, and stratigraphic traps result.

Unconformities

It is implies the surface of erosion or nondeposition separating sequences of layered rocks, as shown in fig. 1-2-6.

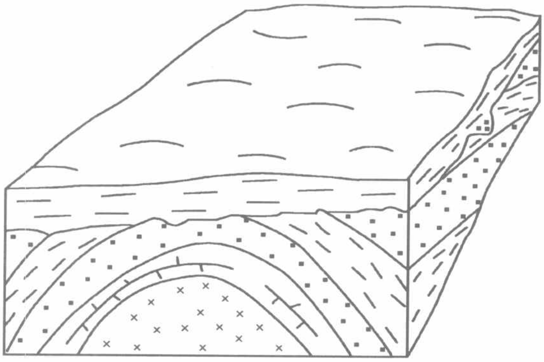

Fig. 1-2-6 Unconformity-a surface between rock layers that shows the effects of a period of erosion or nondeposition.

Whenever the sea withdraws and the landscape is exposed to the elements, erosional processes take command[5]. Physical weathering, such as rainfall, the resulting runoff as streams, wind action, and perhaps glacial scouring, work to lower and level the lands. Chemical processes form soils and dissolve soluble rocks such as limestones and evaporates. Structurally formed topography can be beveled to a near plain, exposing the eroded edges of formations that may have been tilted in the process. When the sea returns and new sediments are deposited on the old eroded land surface, the surface of contact is called an "unconformity". If the old rocks have been tilted and beveled before burial by near-horizontal beds, the surface is called an "angular unconformity". The presence of an unconformity in the layered sequence of rocks indicates that some increment of time is missing in the rock record. These gaps in the record are at least as important as the rocks and markedly affect their distribution.

Oil and gas migrating upward along inclined rock layers may be trapped at an unconformity if the beds overlying the eroded surface are impermeable. Oil and gas may also have migrated along the unconformity.

★课文注释：

[1] weathered fragments 风化碎屑

[2] Weathering processes, such as freezing and thawing, rain, wind, and other similar events, break down the parent rock into small particles that can then be transported by wind and rain runoff. 风化作用，例如冰冻、冰融、雨水淋蚀、风吹和其他类似作用，把母岩破碎为能为风和水流所带走的小颗粒岩屑。

[3] in a relative sense 在某种意义上

[4] In that sense, a geologic time scale was developed in the 1800's to make handy "boxes" of relative time periods in order to think of events in an understandable manner. "Periods" and "eras" were named to designate varying intervals of time that then seemed to be useful. 基于这种认识，在19世纪开始研究地质时间尺度，其应用简单的相对时间间隔简化处理"规范"，以一种容易理解的方式来处置一些地质事件。采用"纪"和"代"来记录变化的时间间隔，该方法看起来是很实用的。

[5] Whenever the sea withdraws and the landscape is exposed to the elements, erosional processes take command. 只要海水退却，地形暴露遭受大自然力量作用，剥蚀作用就发生了。the elements 大自然的力量(风、雨等)。

★专业词汇：

algae 藻类

angular unconformity 角不整合

anticline 背斜

aragonite 霰石，文石

calcite 方解石

carbonate rock 碳酸岩

clastic rock 碎屑岩

depression 洼地，凹陷，盆地

dolomite 白云灰岩

dome 穹隆构造

evaporitic rock 蒸发岩

fault 断层

fossil 化石

fracture 裂缝

granite 花岗岩

gypsum 石膏

halite 盐岩

igneous rock 火成岩

monocline 单斜构造

normal fault 正断层

porosity 孔隙度

reverse fault 逆断层
silica 硅石
stratigraphy 地层学
structural trap 构造圈闭
syncline 向斜
thrust fault 逆掩断层
unconformity 不整合
weathered fragments 风化碎屑

1－3 Exploration

Three conditions must be present for an oil or gas field to exist: (1) a source rock, such as shale, that is rich in organic material; (2) a reservoir rock, such as porous and permeable limestone, dolomite, or sandstone; (3) a trapping mechanism, such as an anticline, faulted strata, or any of the myriad kinds of stratigraphic traps. Petroleum geologists must do everything possible to search for areas where all of these conditions are met. One must gather as many clues as possible (there are never really enough), the clues must be studied and interpreted individually, and then with a great deal of data compilation and imagination a recommendation to explore can be made. Usually patterns will develop, everything falls into place[1] at an unexpected time, and the "drilling prospect" is ready to sell to management or investors. Yet the very best prospect in the world, where everything seems to be perfect, is suspect and risky until it is actually drilled. The cost of drilling and completing a well can be in excess of a million dollars, and the probability of success in a wildcat well is only about one in nine.

There are as many ways to search for oil as there are petroleum geologists. Usually a geologist begins by searching for an area with a thick section of sedimentary rocks. The more layers of rock present, the better the opportunities for porous and permeable rocks to exist; the source rocks must be deeply buried for long periods of time for hydrocarbons to be generated from organic matter. Thickness of the rock column can be determined by studying rock exposures in stream gullies and roadcuts. Wells drilled for water, or previously drilled oil and gas wells also provide information.

Locating traps is not easy, but structural traps are the most obvious kind. The easiest and least expensive method is to map the location and attitude of rocks exposed at the surface[2]. Folds and faults can often be detected in surface exposures, and aerial photos and satellite images may give clues to the presence of structures too large or too obscure to be noticeable at the surface. However, most of these more obvious structures have been previously mapped and drilled. Consequently, other techniques must be used to find structures beneath the surface of the earth that cannot be seen at the surface.

Some fundamentals of geophysical exploration

There are several means of exploring the Earth by geophysical methods. Each of these techniques exploits fundamental physical aspects of Earth materials such as electrical, magnetic, acoustical, or gravitational properties. While these techniques do not allow detailed examination of the rocks beneath us, they often enable geologists and geophysicists to infer the most likely properties of large volumes of rocks.

Gravity methods

The Earth' s gravitational attraction varies slightly from one place to another on the Earth' s surface. Some of this variation occurs because the Earth is not a perfect sphere, and some is related to differences in elevation on the Earth' s surface. While these variations in gravity are predictable and can be calculated for each spot on the Earth' s surface, other variations in gravity, such as those caused by unknown geologic features are not predictable.

Gravity measurements are made with an instrument known as a gravity meter, and maps can be produced that show differences in the pull of gravity across the area. These variations are useful in locating geologic faults and ancient volcanoes, for example. They can also indicate the presence of geologic basins that are filled with unusually large thicknesses of sedimentary rocks.

Magnetic methods

The Earth' s magnetism varies from place to place, much as the gravity varies. The variation in strength of the magnetism is caused primarily by concentrations in rocks of a magnetic mineral called magnetite. Rocks such as granite and sandstone have a high magnetite content relative to such rocks as limestone and shale.

Seismic Method—Seismic-reflection prospecting

Seismic reflection, a powerful technique for underground exploration, has been used for over 60 years. Seismic waves are essentially sound waves that travel underground at velocities of 3 to 6 km per second, depending upon the type of rock through which they pass.

Seismic-reflection techniques depend on the existence of distinct and abrupt seismic-velocity and/or mass-density changes in the subsurface. These changes in either density or velocity are known as acoustical contrasts. The measure of acoustical contrast (formally known as acoustic impedance) is the product of mass density and the speed of seismic waves traveling within a material. In many cases, the acoustical contrasts occur at boundaries between geologic layers or formations, although man made boundaries such as tunnels and mines also represent contrasts.

A source of seismic waves emits into the ground, commonly by explosion, truck-mounted vibrators, mass drop, or projectile impact[3]. Waves are radiated spherically away from the source. One ray originating at the source will pass through subsurface layers and part of them reflects back at every formation interface, then the echo return to the receiver at the surface. In the case of a single flat-lying layer and a flat topographic surface, the path of least time will be from a reflecting point midway between the source and the receiver with the angle of incidence on the reflecting layer equal to the angle of reflection from the reflecting layer, as shown in fig. 1-3-1.

The sound receivers at the surface are called geophones and are essentially low-frequency microphones. Signals from the geophones are transmitted by seismic cables to a recording truck, which contains a seismograph. The seismograph contains amplifiers that are very much like those

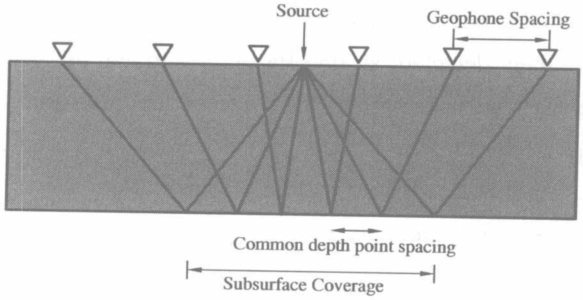

Fig. 1-3-1 Schematic drawing of seismic-ray paths for a single shot with a six-channel reflection seismograph.

on a stereo music system. The sounds returning from the Earth are amplified and then recorded on digital computer tape for later processing and analysis. The purpose of computer processing is to separate echoes from other sounds, to enhance the echoes, and to display them graphically.

In the real world, several layers beneath the Earth's surface are usually within reach of the seismic-reflection technique. Note that echoes from the various layers arrive at the geophone at different times. The deeper the layer, the longer it takes for the echo to arrive at the geophone. Because several layers often contribute echoes to seismograms, the seismic data become more complex.

In the case of a multi-channel seismograph, several geophones detect sound waves almost simultaneously. Each channel has one or more geophones connected to it. Reflections from different points in the subsurface are recorded by various geophones. Note that the subsurface coverage of the reflection data is exactly half the surface distance across the geophone spread. Hence, the subsurface-sampling interval is exactly half the geophone interval at the surface. For example, if geophones are spaced at 16 m intervals at the Earth's surface, the subsurface reflections will come from locations on the reflector that are centered 8 m apart.

The seismic-reflection method is used to determine the spatial configuration of underground geological formations.

To detect small geologic features, it is necessary to use a seismograph that can record and enhance high-frequency sound waves. The use of high-frequency seismic waves in reflection seismology is known as "high-resolution" seismic exploration. As research and instrumentation developments allow recording higher and higher seismic frequencies, it is becoming possible to prospect for progressively smaller geologic targets.

Seismic reflection is sensitive to the physical properties of Earth materials and is relatively insensitive to chemical makeup of both Earth materials and their contained fluids. The seismic-reflection technique involves no assumptions about layering or seismic velocity. However, no seismic energy will be reflected back for analysis unless acoustic impedance contrasts are present within the depth range of the equipment and procedures used[4]. The classic use of seismic reflections involves identifying the boundaries of layered geologic units. It is important to note that the technique can also be used to search for anomalies such as isolated sand or clay lenses and cavities.

Fig. 1-3-2 depicts a single explosive charge fired in a drilled hole to provide a source of seismic waves for a seismic-reflection survey. The seismic waves echo from underground rock layers. These echoes are then detected at the Earth's surface by geophones. The signals are recorded by truck via cables. The seismograph's amplifiers condition and amplify the data and send the data to a digital tape recorder. The signals are processed in a computer to produce a final display called a seismic section. The seismic section displayed here shows echoes from rock units a few hundred feet below the Earth's surface.

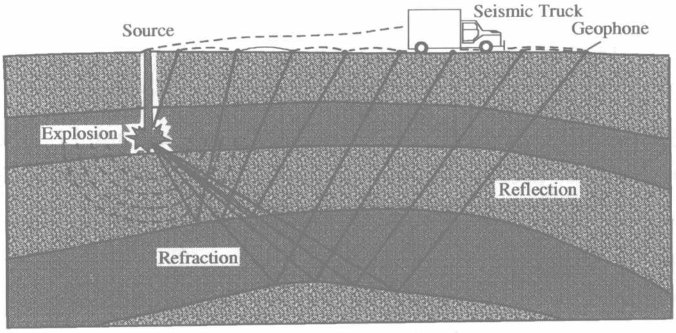

Fig. 1-3-2 Schematic cross section of geology, seismic-ray paths.

Subsurface geology

When a well is drilled in the search for petroleum, samples of the rock layers encountered are saved. Studying these "drill cuttings" (chips of rock produced by the drill bit) and "cores" (continuous columns of rock cut during drilling) allows petroleum geologists to identify the rock layers present in that locality and their natural sequence. Geologists can also see the nature of any porosity and can detect the presence of oil in the rock. A continuous graphic and written record (strip log) of the observed rocks is made for future use.

When a hole reaches its projected depth ("total depth"), geophysical logs are run in the hole to measure different properties of the rocks encountered.

"Electric logs" measure naturally existing electrical currents and how the rocks transmit induced electrical currents. These logs detect porous zones and the nature of the contained fluids. Saltwater is a good conductor of electricity, while freshwater and hydrocarbons are not, thus the presence of saltwater (most deep underground waters are saline) can be determined and distinguished from petroleum. Oil-field waters are highly variable in salinity, ranging from near freshwater to concentrated brines.

"Gamma ray-neutron logs" are records of the presence of naturally occurring radioactive minerals, even in minute quantities and show how the rocks respond to induced radioactive particles. Shale is more radioactive than sandstone or limestone and is thus distinguishable from them. When the rock is bombarded with neutrons, any hydrogen present in the rocks absorbs the radioactive particles. As any naturally occurring fluids, either hydrocarbons or waters, contain hydrogen, their presence is indicated and an indirect measurement of the rock porosity is recorded.