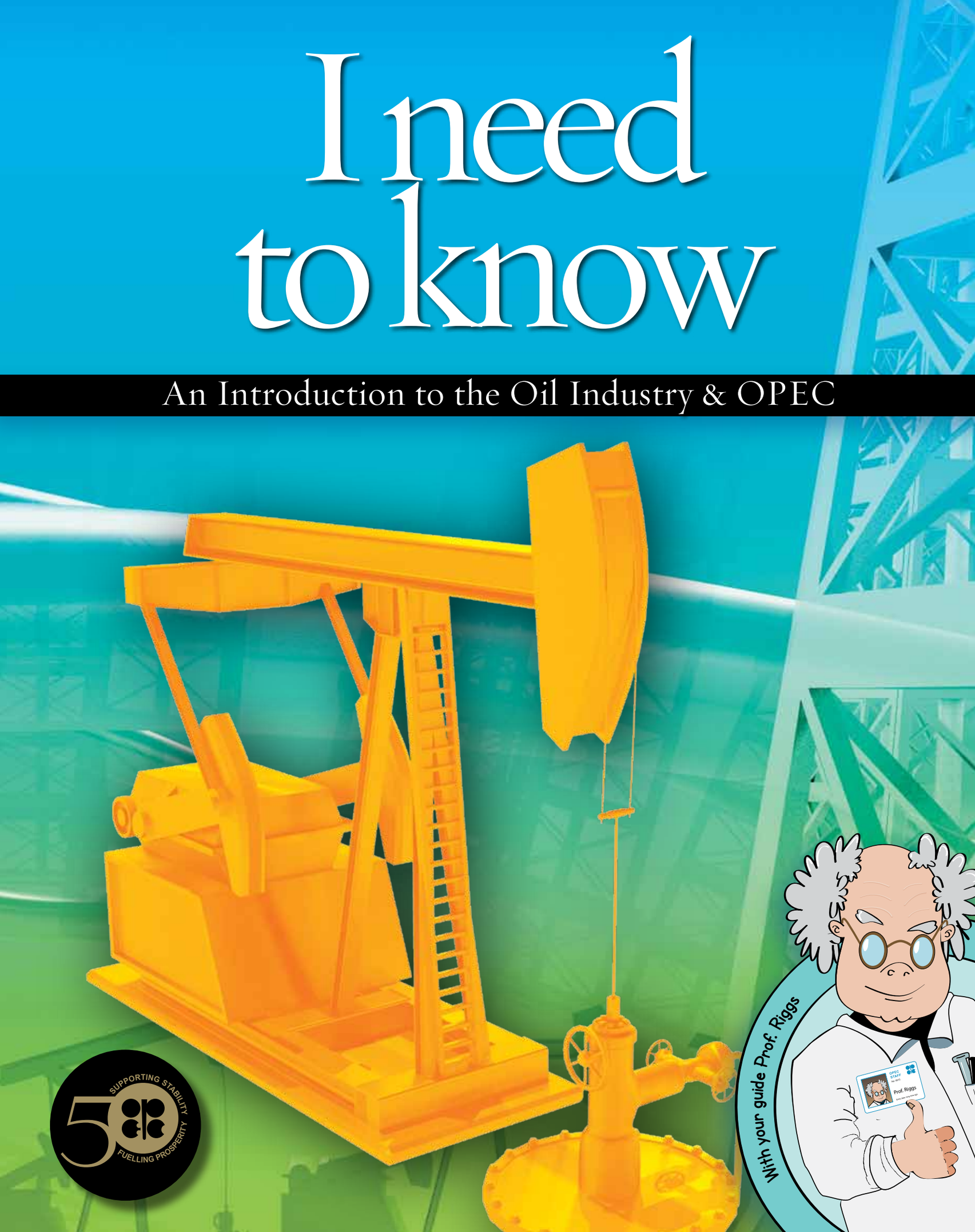
I need to know

An Introduction to the Oil Industry & OPEC



I need to know

AN INTRODUCTION TO THE OIL INDUSTRY & OPEC

OPEC Secretariat
Public Relations & Information Department

Second edition

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This book
is dedicated
to children and
all young people
around the
world.

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Hello! My name is Prof. Riggs and I will guide you through this exciting book.

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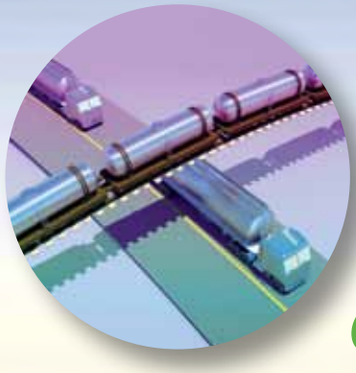

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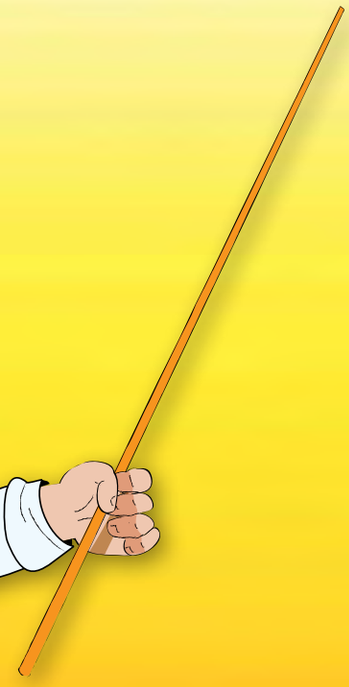
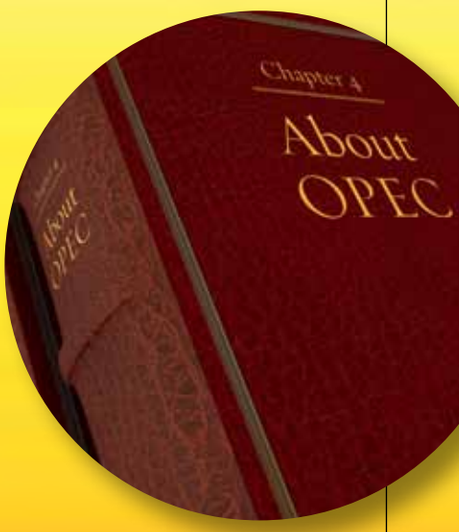




Foreword

There is a first time for everything. This illustrated student's guide to the oil industry is certainly an exciting first for OPEC. Similarly, preparing an introduction for it is a first for me. But it is a task of great importance.

This book is not only about an industry that is central to the way we live today—and to the creation of economic opportunities around the world—it addresses people who will become the business and political leaders of tomorrow.

Whether they live in oil consuming or producing countries like OPEC's own Member Countries, the words in this book are directed at young people everywhere. The challenges of our world will someday be yours; and the more you know and understand about the world's most important energy source—oil—the better prepared you will be to respond to the challenges of the future.

Learning about the history of OPEC and its growing role in the international community is also important. In many ways, the story of OPEC is the modern history of oil. Since its founding in 1960, OPEC has consistently sought to bring stability to the oil market. It has also tried to help others understand the workings of the oil industry, the activities of its Member Countries and many other aspects of a global industry.

Now, more than 50 years later, OPEC continues to look for opportunities to further understanding, especially among the world's young people.

I sincerely hope you will enjoy this book. It aims to make learning about the oil industry—and OPEC's role in it—interesting.

It is with great pride that we present this book. It is my hope that after reading it, the oil industry will start to become as compelling to you as it has been for me, and the many men and women who have worked in it for many, many years.

Abdalla Salem El-Badri

Secretary General

Introduction

I need to know: An Introduction to the Oil Industry and OPEC tells the story of oil. It tells how crude oil—or, using its more technical term, petroleum—was discovered, how it is explored and taken from the ground and made into other products. Over the last 150 years, oil has had many benefits and applications in our world—in industries, in medicine, at home and in transportation. It has shaped our world in many important ways.

Although talking about oil and its production may sound complicated, this book is meant to simplify it. It is a book that both young people and adults can enjoy. It has been written so that novices can learn something about the origins of oil and the basics of the oil industry. Thus, the language used has been kept as non-technical as possible and the illustrations help to break down the complex nature of the topic.

While this book is conceived as a history of oil, the reader will also be able to learn about the Organization of the Petroleum Exporting Countries (OPEC), which celebrated its fiftieth anniversary in 2010.

There is no doubt that turning fifty years old is a milestone. When OPEC was founded, few could have predicted that it would have lasted as long as it has. More than that, it has since developed into an important global actor. In fact, the slogan for OPEC's Golden Jubilee year—"supporting stability, fuelling prosperity"—captures the essence of OPEC's activities over the last fifty years, and reflects the work it has done in contributing to global economic growth.

The book tries to raise awareness of the Organization's important role in ensuring a regular and adequate supply of oil to the global markets. It also provides a summary of the founding of the Organization in 1960, explains its membership and structure, and considers some of the frequently asked questions that people have about OPEC.

As OPEC's Secretary General, Abdalla S. El-Badri, has noted in the past, "OPEC is the oldest surviving inter-governmental organization composed wholly of developing countries." This is an admirable achievement, especially considering that it has survived a lot of challenges in the past.

"OPEC is the oldest surviving inter-governmental organization composed wholly of developing countries."

Secretary General, Abdalla S. El-Badri, OPEC

The book is divided into four chapters. **Chapter I** provides a brief history of the oil industry and highlights key facts about petroleum. This includes the origins of the word 'petroleum' and the definition of crude oil. It provides summary explanations about how crude oil was formed and why investments are so important for its ongoing development.

Chapter II describes how oil is found. It considers the investments that are needed for exploration projects and examines how much oil is needed around the world.

Chapter III then focuses on how oil is extracted, brought to the market and refined into useful products. It identifies and explains the differences between the 'upstream' and the 'downstream' sectors of the industry. A description of the different ways of exploring for oil, as well as the various methods used to transport it, are also explained.

Finally, **Chapter IV** provides an overview of the history of OPEC, explaining the background and the circumstances that led to its founding and the requirements for membership. There is also a brief description of the Organization's overall mission and objectives, and an explanation of the Secretariat's organizational structure. The commitment of OPEC Member Countries to assisting developing countries, which they pursue through the OPEC Fund for International Development (OFID), is also described.

It is our hope that whoever reads this book will be able to better understand OPEC's vital role in the global economy and the challenges it faces. As it enters its sixth decade, OPEC is well prepared to meet these new challenges.

Chapter 1

Oil Basics

WHAT IS CRUDE OIL?

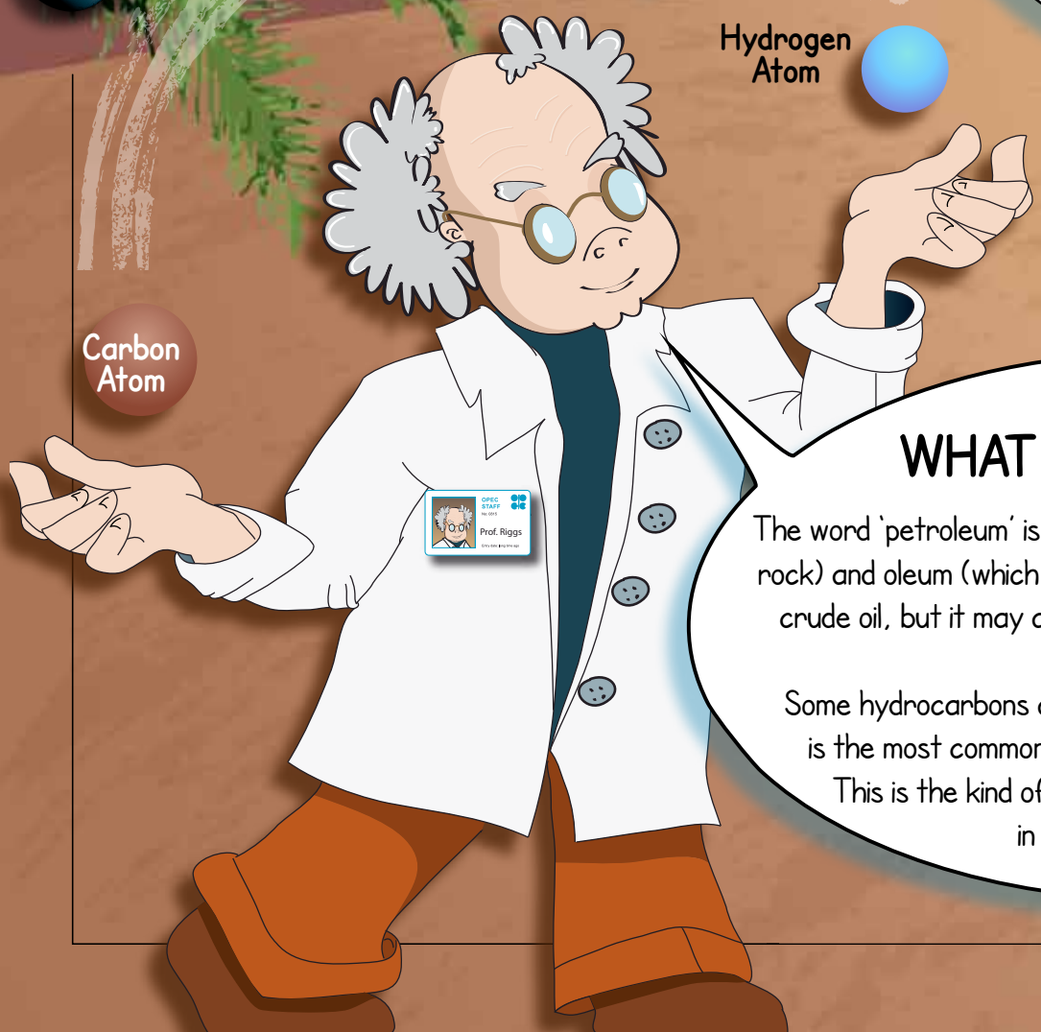
Crude oil is an organic liquid substance often found below the Earth's surface. It is made up of thousands of molecules composed of different hydrogen and carbon atoms. Such compounds are called ***hydrocarbons***.

These hydrocarbons also contain different proportions of impurities like oxygen, sulphur, nitrogen and heavy metal atoms.

Hydrogen Atom

Hydrogen Atom

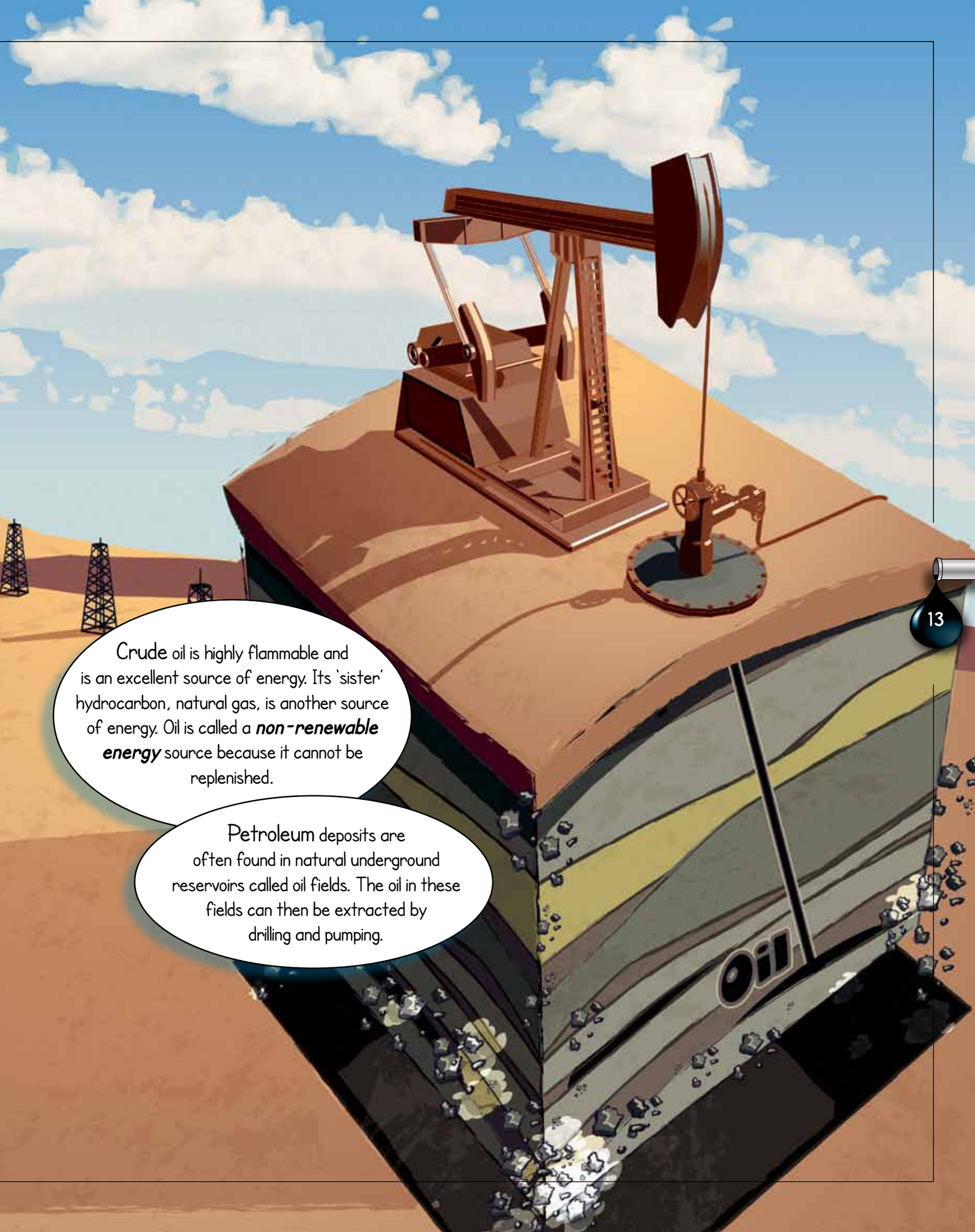
Carbon Atom

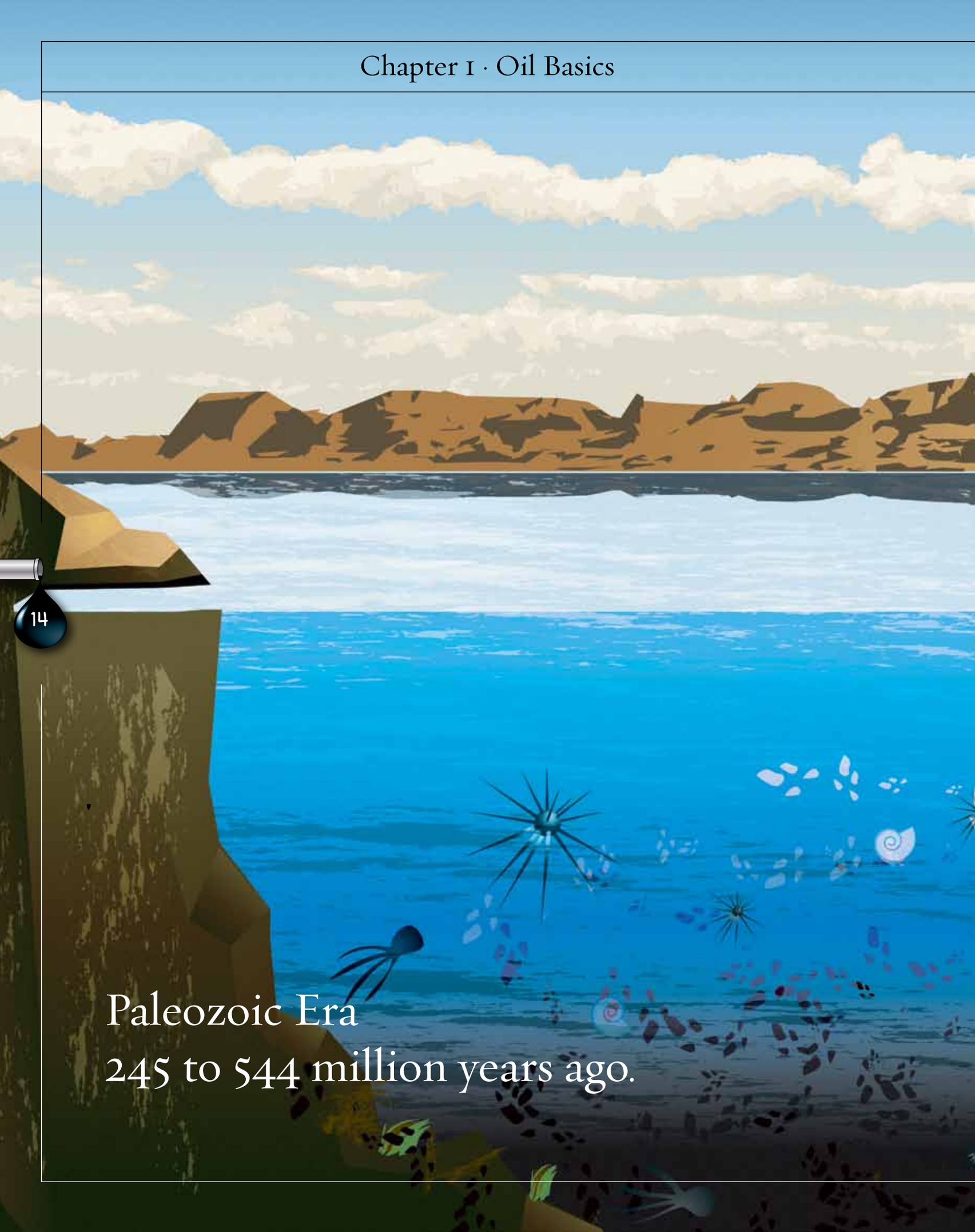


WHAT IS PETROLEUM?

The word 'petroleum' is derived from the Latin petra (which means rock) and oleum (which means oil). It is commonly used to refer to crude oil, but it may also refer to other related hydrocarbons.

Some hydrocarbons are gaseous, rather than liquid. Methane is the most common example of these hydrocarbon gases. This is the kind of natural gas that we most often use in our kitchens at home.


Crude oil is highly flammable and is an excellent source of energy. Its 'sister' hydrocarbon, natural gas, is another source of energy. Oil is called a ***non-renewable energy*** source because it cannot be replenished.
Petroleum deposits are often found in natural underground reservoirs called oil fields. The oil in these fields can then be extracted by drilling and pumping.
Oil
13

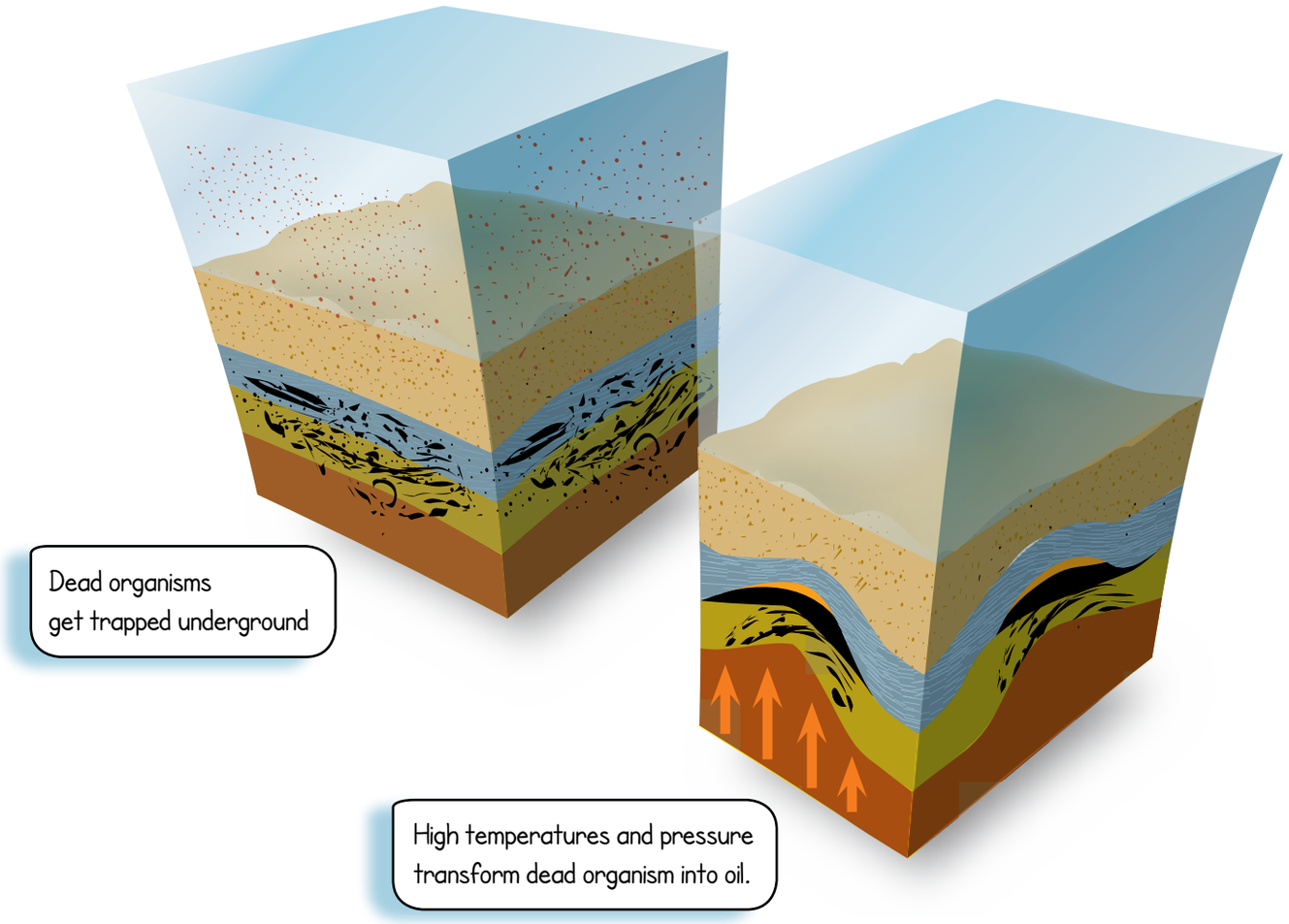


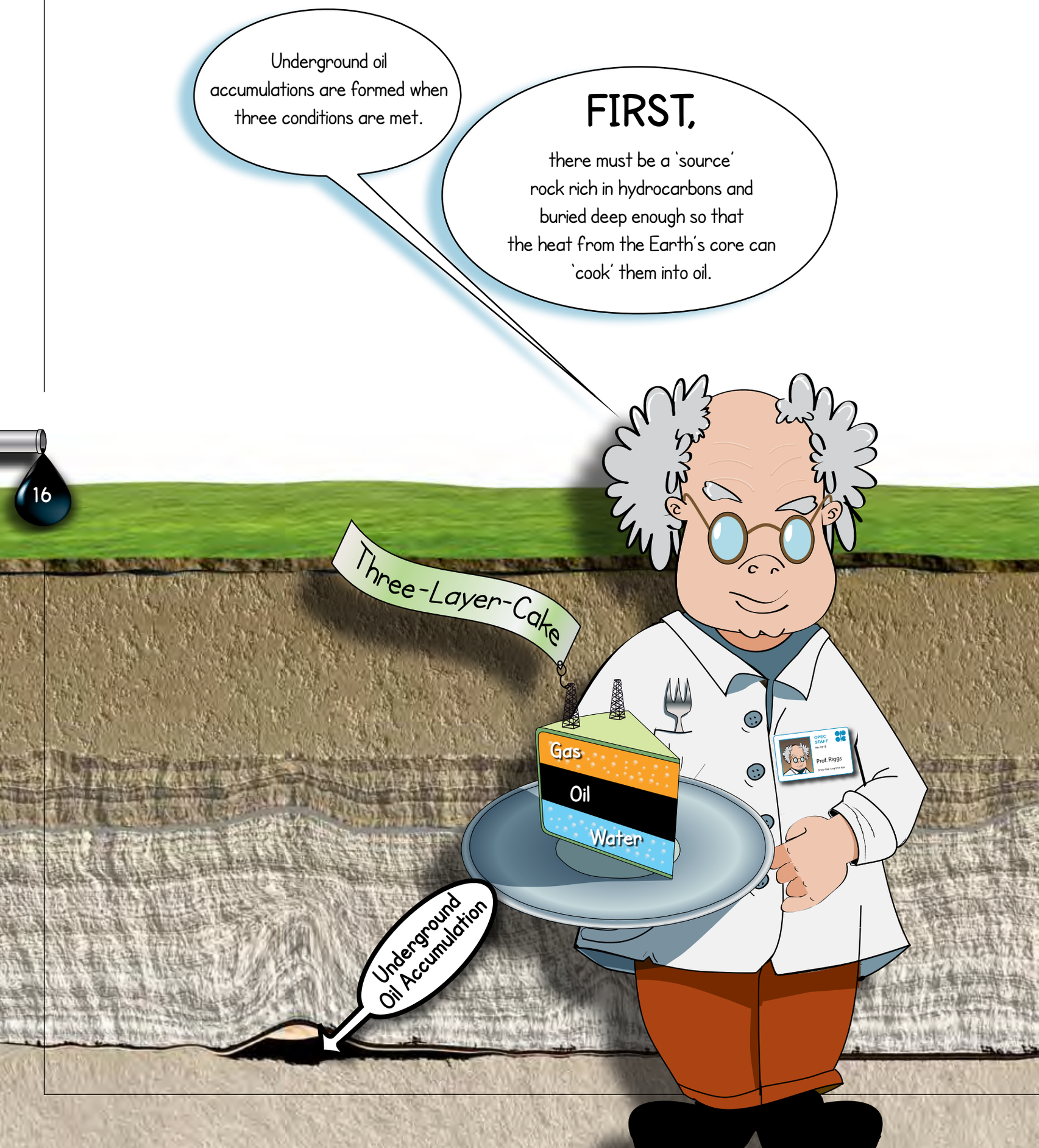
Paleozoic Era
245 to 544 million years ago.

How is oil formed?

Oil is formed from the accumulation of hydrocarbons. Hydrocarbons accumulate naturally, thousands of feet below the surface of the Earth, from the decomposition of organic materials like plants and marine animals which died during the Palaeozoic Era (between 245 and 544 million years ago).

Trapped beneath the ground under enormous pressure and high temperatures, these hydrocarbons were compressed and eventually transformed into crude oil after millions of years.




Underground oil accumulations are formed when three conditions are met.
FIRST,
there must be a 'source' rock rich in hydrocarbons and buried deep enough so that the heat from the Earth's core can 'cook' them into oil.
16
Three-Layer-Cake
Gas
Oil
Water
Underground Oil Accumulation
OPEC STAFF
Prof. Riggs

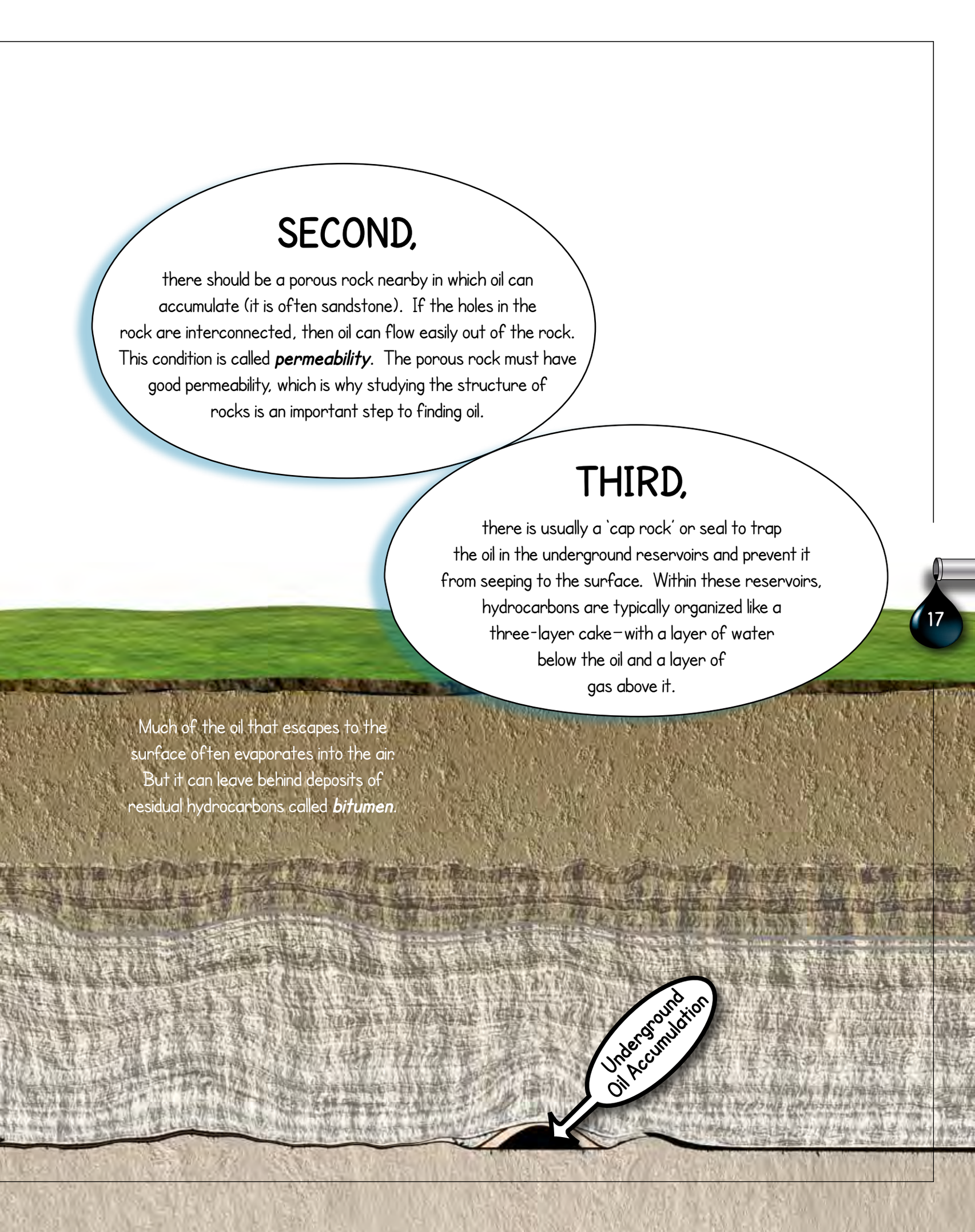
SECOND,

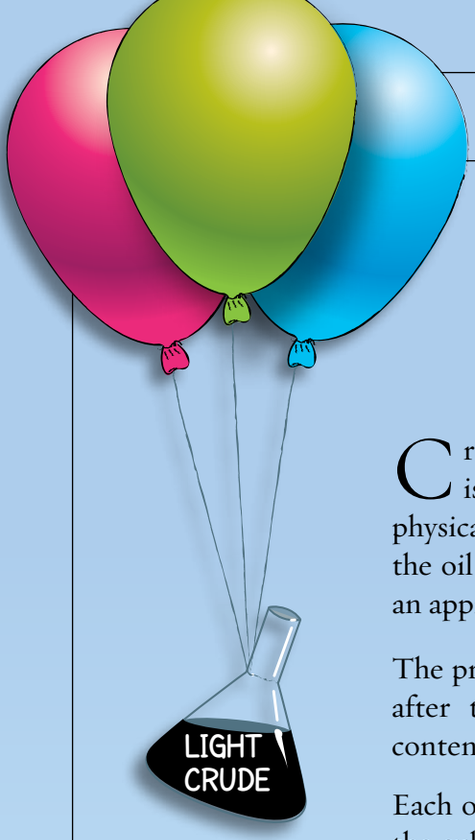
there should be a porous rock nearby in which oil can accumulate (it is often sandstone). If the holes in the rock are interconnected, then oil can flow easily out of the rock. This condition is called ***permeability***. The porous rock must have good permeability, which is why studying the structure of rocks is an important step to finding oil.

THIRD,

there is usually a 'cap rock' or seal to trap the oil in the underground reservoirs and prevent it from seeping to the surface. Within these reservoirs, hydrocarbons are typically organized like a three-layer cake—with a layer of water below the oil and a layer of gas above it.

Much of the oil that escapes to the surface often evaporates into the air. But it can leave behind deposits of residual hydrocarbons called ***bitumen***.





Oil properties

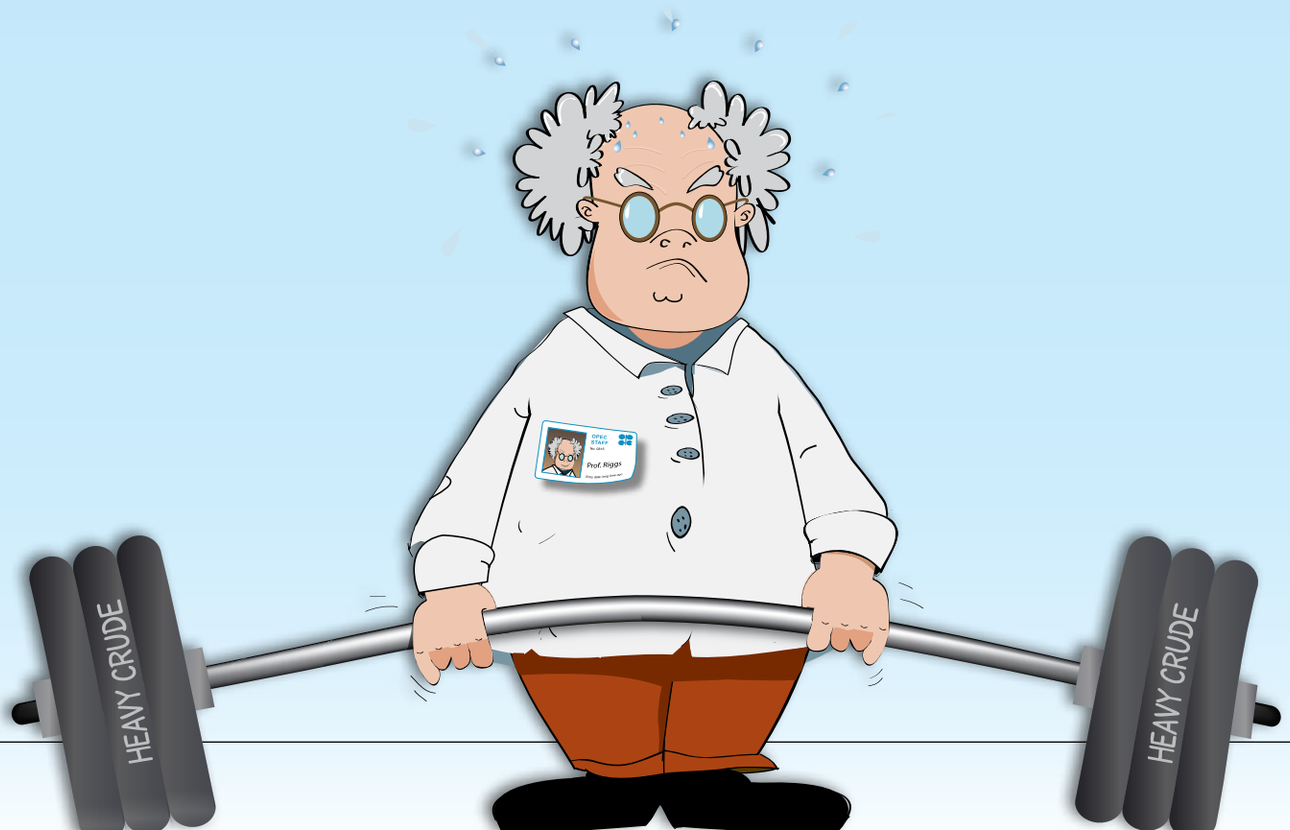
Crude oil properties can vary widely depending on where the oil is found and under what conditions it was formed. Its different physical properties are used to design the right kind of refineries, classify the oil (for example, West Texas Intermediate or Oman) and determine an appropriate price for it.

The properties of oil include its density, called the ***API gravity*** (named after the American Petroleum Institute), sulphur content, nitrogen content, carbon residue and distillation range.

Each of these properties is important for different reasons. For example, the sulphur content of crude oil is important because it determines the kind of treatment that it will require at a refinery. The higher the sulphur level, the bigger the effect it will have on the environment—and the more corrosive effect it will have on equipment.

API gravity is also important. It is essentially a measure of density. It determines whether a specific type of crude oil has a higher or lower boiling range (or ***distillate yields***), which is important for separating and extracting different parts (or ***fractions***).

Different oil-producing areas produce different kinds of crude oil. And depending on its mixture of hydrocarbons, crude oil can vary in colour, composition and consistency.



It is quite common to classify crude oil into different types or ***grades***. The following classifications are most common.

Light / Heavy

Crude oil can be classified as either ***light*** or ***heavy*** depending on its API gravity (or density). Generally, the higher its API gravity, the lower its density.

Oil that is lighter in colour, has a thin consistency and flows easily usually contains less metals and sulphur compounds. It is known as light oil.

Oil that is high in metal and sulphur content is considered low-grade oil. It generally has too much carbon, not enough hydrogen and is more time-consuming to produce and hard to refine. It is known as heavy oil.

Sour / Sweet

Crude oil can also be classified as either ***sour*** or ***sweet***, depending on the amount of sulphur it contains.

Oil with a high sulphur content (0.5% and above, by weight) is considered sour.

Sweet crude oil, on the other hand, has low amounts of these sulphur compounds.

REFERENCE CRUDE OIL Some common crude oil types are used as a reference or ***benchmark*** to determine the value of other crude oils. Some of these reference crude oils are:

Brent Blend
A blend of several crude oils from fields in the North Sea region, located above Germany and the United Kingdom. The price of oil produced in Africa, Europe and the Middle East tends to be based on this oil.

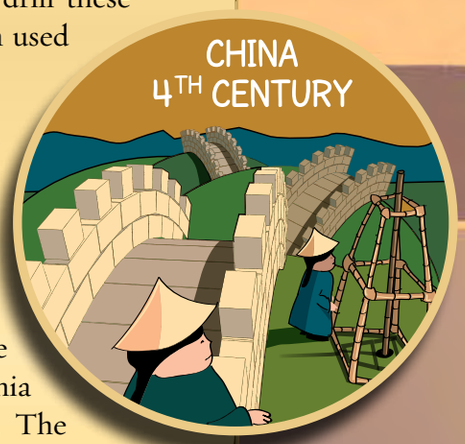
Dubai-Oman
Used as a benchmark for Middle East sour crude oil flowing to the Asia-Pacific region.

Tapis Crude
Oil produced in Malaysia that is used as a reference for light oil from East Asia.

West Texas Intermediate (WTI)
A very high-quality, sweet, light oil produced in North America.

A brief history of the industry

The world's first oil wells were drilled in China around the 4th century AD. The Chinese used simple bamboo poles to drill these wells. The dark, sticky material they extracted was then used primarily as a source of fuel.



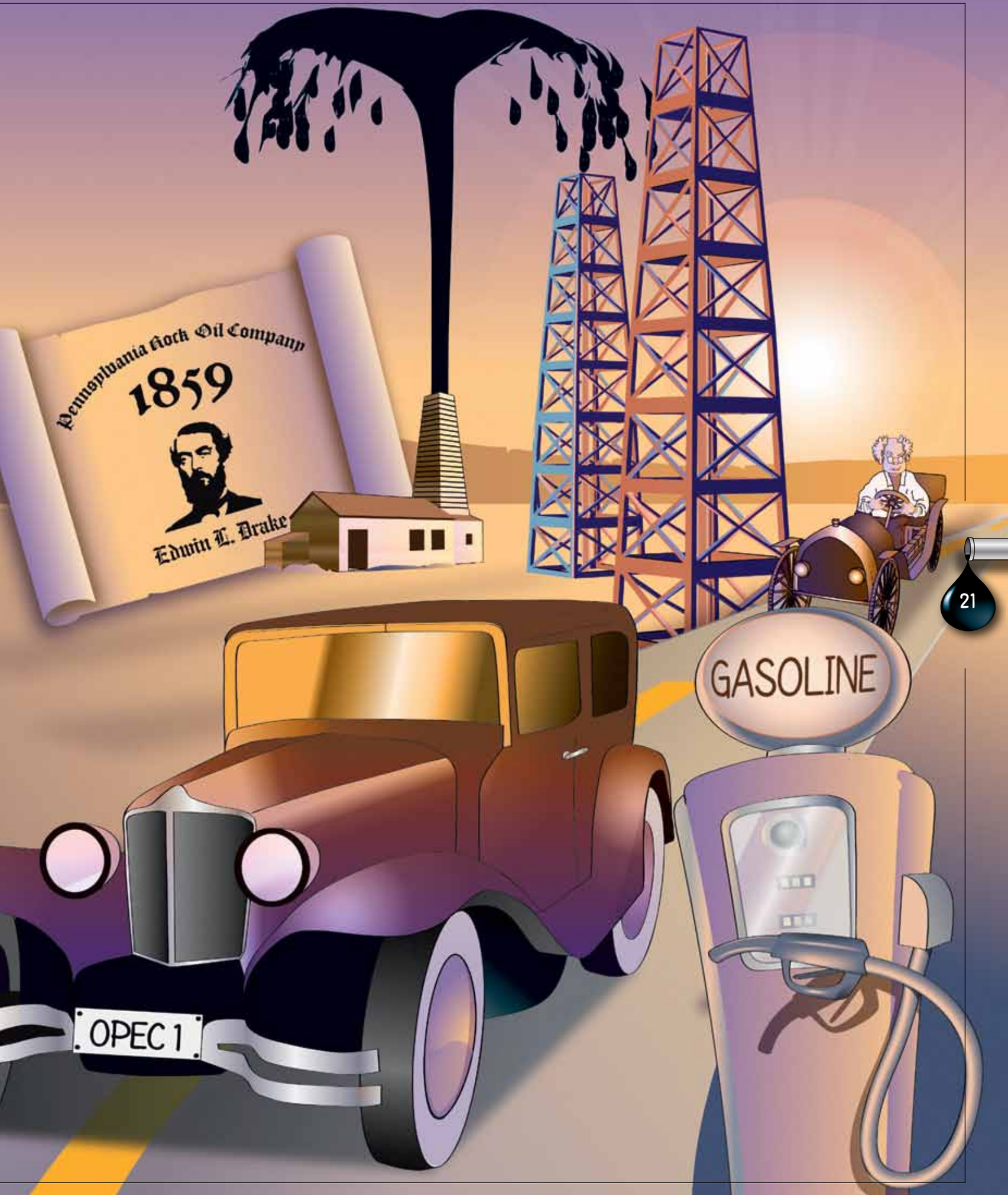
In later centuries, oil was found across Asia and Europe. Sometimes it accumulates in natural pools above the ground. Travellers and settlers used the mysterious black liquid for fuel, as well as for medical treatment.

The modern oil industry began in the mid-19th century. On August 27, 1859, Colonel Edwin Drake discovered the first underground oil reservoir near Titusville, Pennsylvania (USA), after drilling a well only 21 metres (69 feet) deep. The oil flowed easily. It was also easy to work with and distil. This oil was known as a paraffin type of oil.

Drake worked for the Pennsylvania Rock Oil Company which wanted to use the oil to light street lamps. Drake's well initially produced 30 barrels of oil per day (b/d). (One barrel is equal to 159 litres or 42 US gallons). Its success marked the beginning of the modern oil industry.

Oil soon began to receive more attention from the scientific community. After some research, a variety of products were eventually developed from crude oil. For example, kerosene for heating was one of the first products.

Soon other products (like gasoline and diesel to run engines) were also on the market. In 1890, the mass production of automobiles began creating a huge demand for gasoline and pushing companies to find more oil fields.


Pennsylvania Rock Oil Company
1859
Edwin L. Drake
GASOLINE
OPEC 1

Why is oil important?

Crude oil is a central part of modern life and the world's most important energy resource. We rely on it in many ways for the food we eat, the clothes we wear and the electronics we use at home and in the workplace. Without oil, we would not be able to continue to enjoy the same standard of living.

The way people live, work and travel all depend on oil. Oil is, in fact, the world's most important transportation fuel. About 90% of all transportation fuels come from crude oil.

Jet fuel

It is also the raw material from which other important products are made, which have improved the quality of our lives over the past century and a half. It has been used to keep people's houses warm during the winter for centuries.

Artificial heart

Aspirin

Synthetic fibres

Shampoo

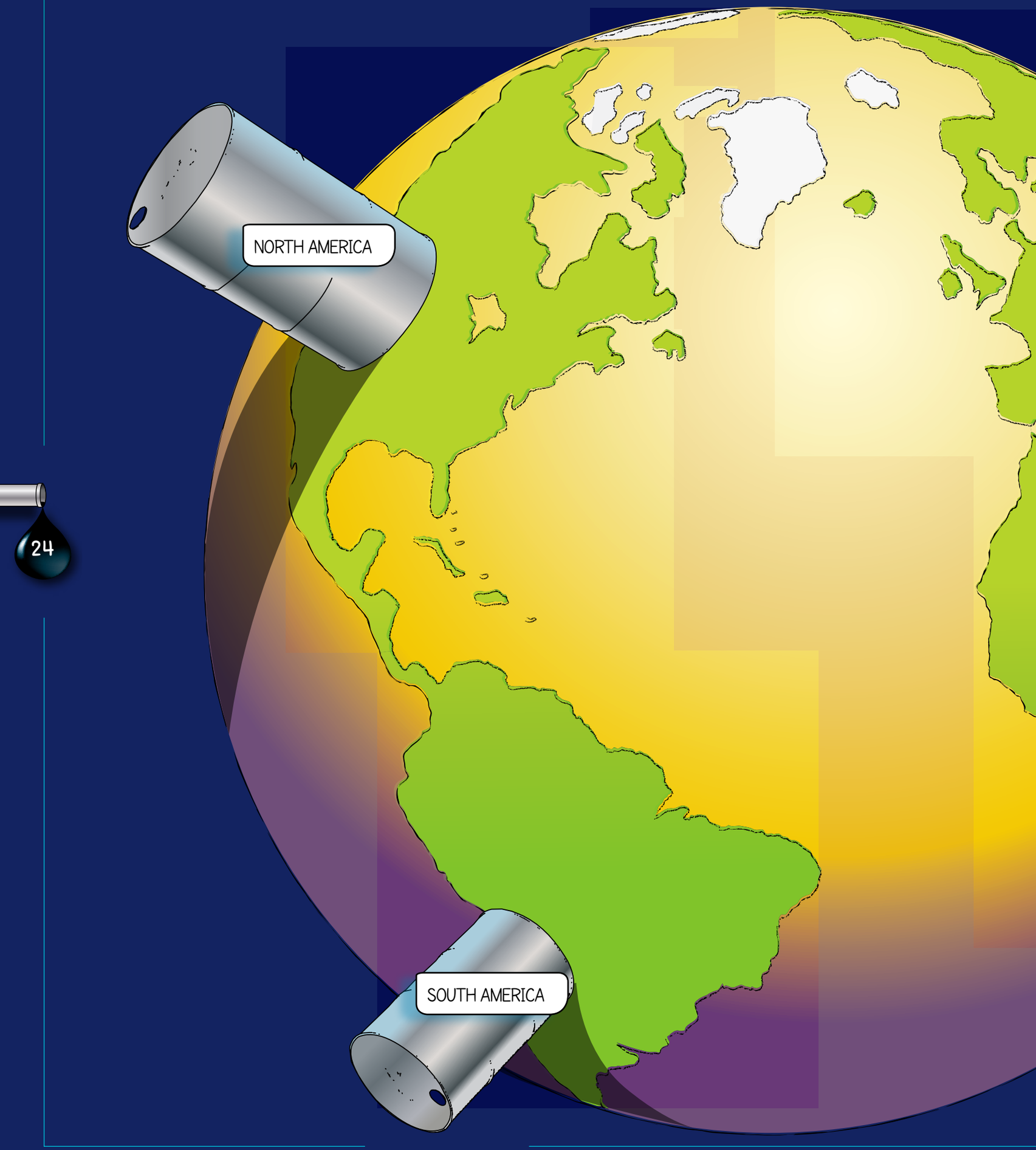
Lipstick

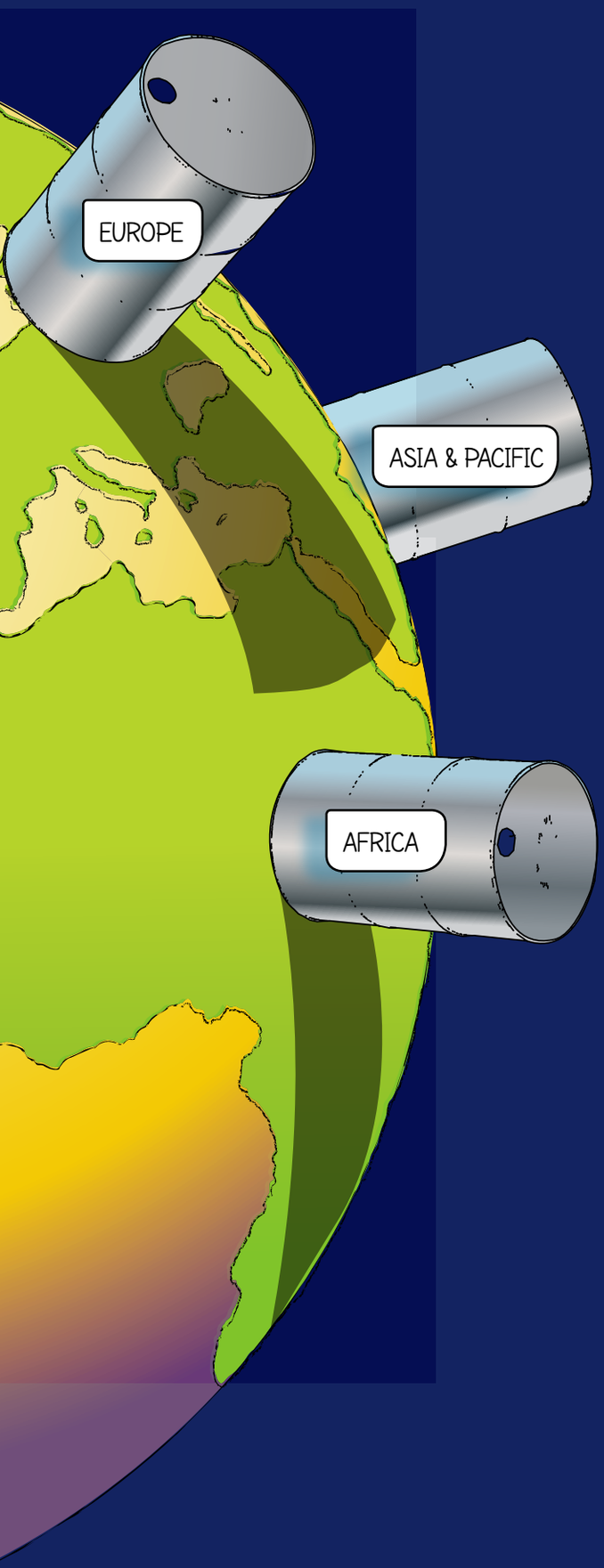
23

But oil is also used to make medicines, plastics and cleaning products. In fact, modern life as we know it today would be impossible without oil and its products. Many of the everyday items people use are either made from oil or are dependent on oil for their production.

Some of these products include heating oil, jet fuel, kerosene, dentures, diapers, fertilizers, lipstick, shampoo, deodorant, shaving cream, crayons, musical devices, cameras, computers, glue, contact lenses, toothpaste, synthetic fibres, tires, artificial hearts and even aspirin.

So now you have an idea of how important oil is in our daily life!


NORTH AMERICA
SOUTH AMERICA



How much Oil does the world need?

The world needs more energy as its population grows and as countries become more economically prosperous.

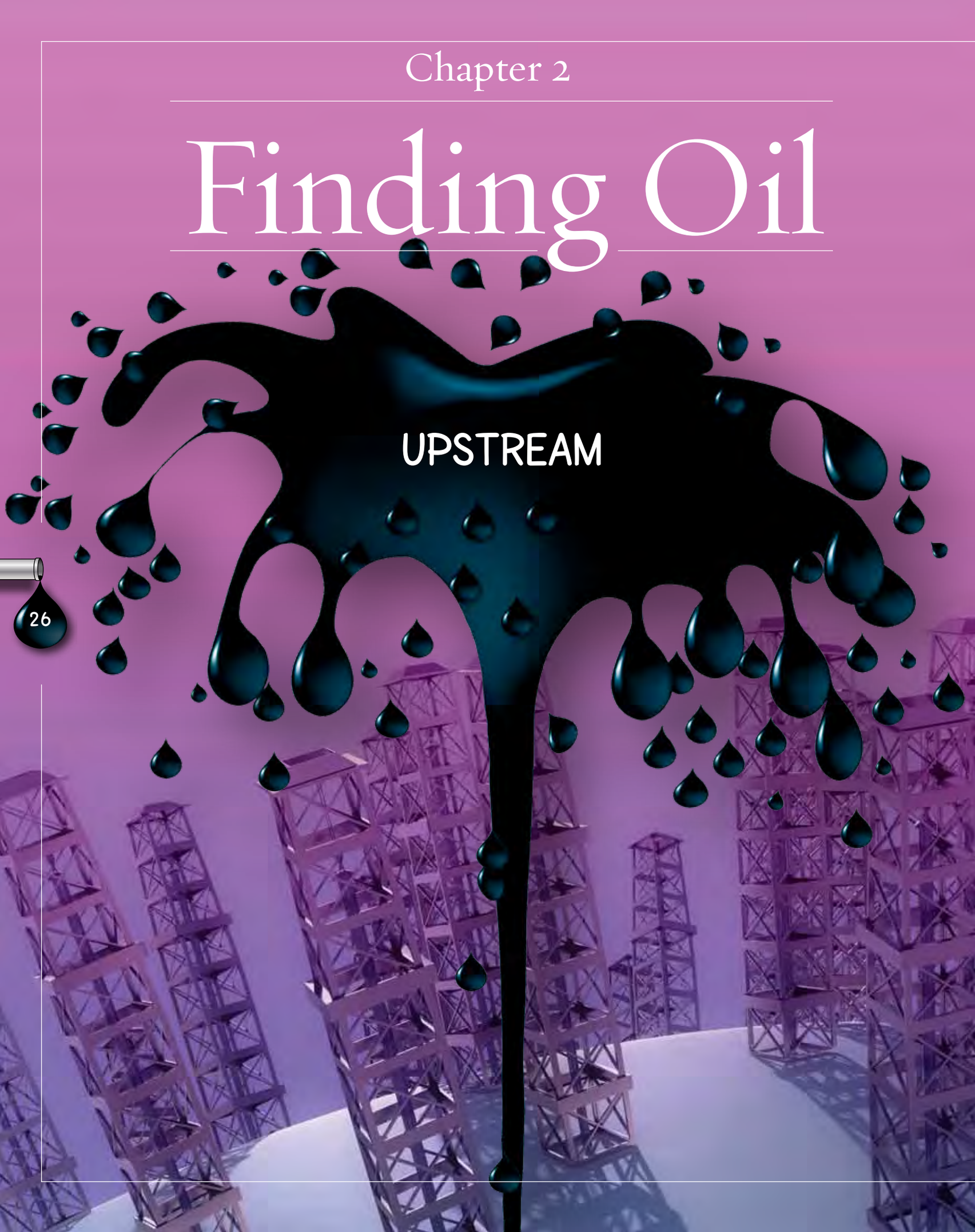
The United States has the world's largest demand for oil. Although it has only about 5% of total world population, it uses nearly 25% of the world's total oil production and 45% of the world's total gasoline production.

And as the economies of countries like Brazil Russia, India and China become richer, and their economies expand, their need for more oil will grow.

To meet all this demand for oil without provoking market imbalances, the right supply levels are needed. Measuring this is always a challenge for the experts who work in the oil industry.

Chapter 2

Finding Oil



A big adventure begins!

Finding oil and getting it out of the ground is a challenging and exciting activity. It requires great effort and travel to distant lands—and the results can often be surprising.

SO HOW DO WE FIND OIL?

It starts with the simple decision to explore for oil based on preliminary survey data. Once oil is discovered, the initial results are tested. If the results are good, then the development of a production well begins.

Because of the importance of oil in our lives, it is necessary to understand how the industry as a whole works in both its upstream and downstream sectors. For this, it is helpful to look at the oil industry by first considering what is called the ***upstream*** sector.

UPSTREAM

The upstream sector is the part of the oil industry involved with finding oil fields and bringing oil up from the ground. Upstream activities include exploratory work, such as the search for underground (or underwater) oil and gas reservoirs, and the initial drilling, followed by the production phase, which is the actual extraction of oil from the ground.

Exploration

Exploration is almost like detective work. It requires looking for clues, careful observation of ground conditions, taking notes of different information and the evaluation of survey data. This is the job of petroleum ***geoscientists***, who are experts on rocks.

Petroleum geoscientists working at oil companies begin looking for places where there might be oil. They look for signs that may indicate the presence of hydrocarbons underground and are responsible for determining the best places to drill.

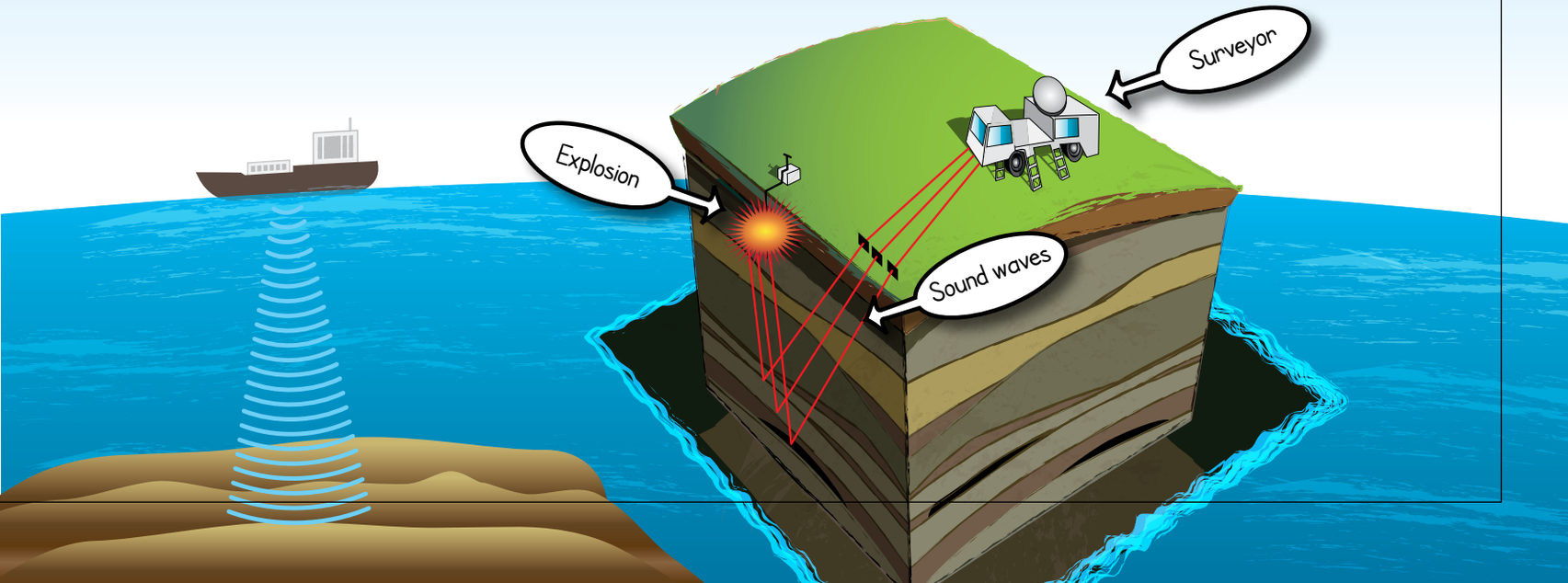
They start by examining the shapes of different underground layers of rock. They have to use special tools in order to 'see' the rocks underground. Thus, using advanced technology—and special tools like aerial photography, satellite pictures and specialized machines that measure variations in the Earth's gravity and magnetic fields—geoscientists try to identify likely crude oil fields.

Oil can also be found underground at the bottom of the sea. In this case, special ships are used to look for these underwater oil fields. Geoscientists use several special technical tools—such as sound waves used in ***seismic technology***—to form a clear picture of underwater rock layers.

But the only way to be absolutely sure that there is oil in the ground is simply to drill a well. This is a big gamble because not all wells result in the discovery of oil. It may take the drilling of many different wells until a new oil field is found. This costs a large amount of money because sophisticated equipment is needed and many people need to be hired.

That is why the geoscientists then supply all their survey data to the economists and financial planners at the oil companies, who help make the decision whether or not to drill exploratory wells.

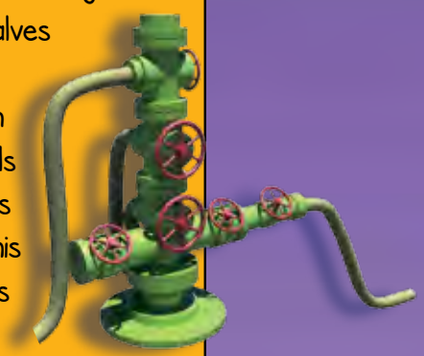
Surveyors record the seismic waves that are produced by an explosion or sound generator. Since different rock types reflect sound waves differently, the surveyor can create a picture of the subterranean rocks.



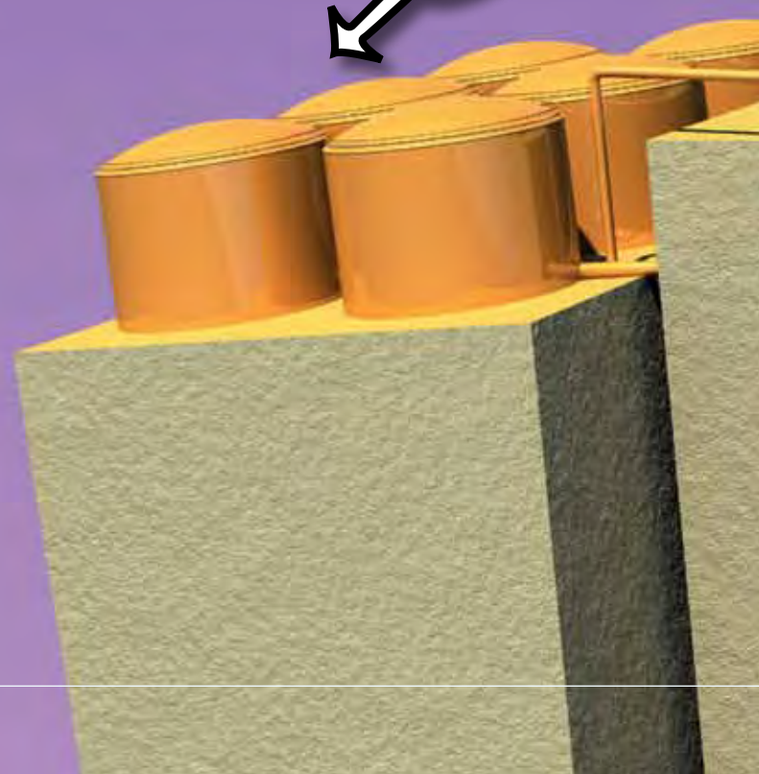
Production

Once oil is found after the preliminary exploration phase and the drilling of exploratory wells, the production phase can begin. There are two forms of drilling: onshore and offshore.

Crude oil found underground is usually mixed with water, sand, salt and natural gas. As it is extracted, the pressure of these different substances must be kept at just the right levels. This is done by turning valves on and off at the surface level. Because these valves are often green in colour and the small dials are red, much like the pine trees decorated at Christmas time, this assembly is often referred to as a ***Christmas tree.***



Storage tanks

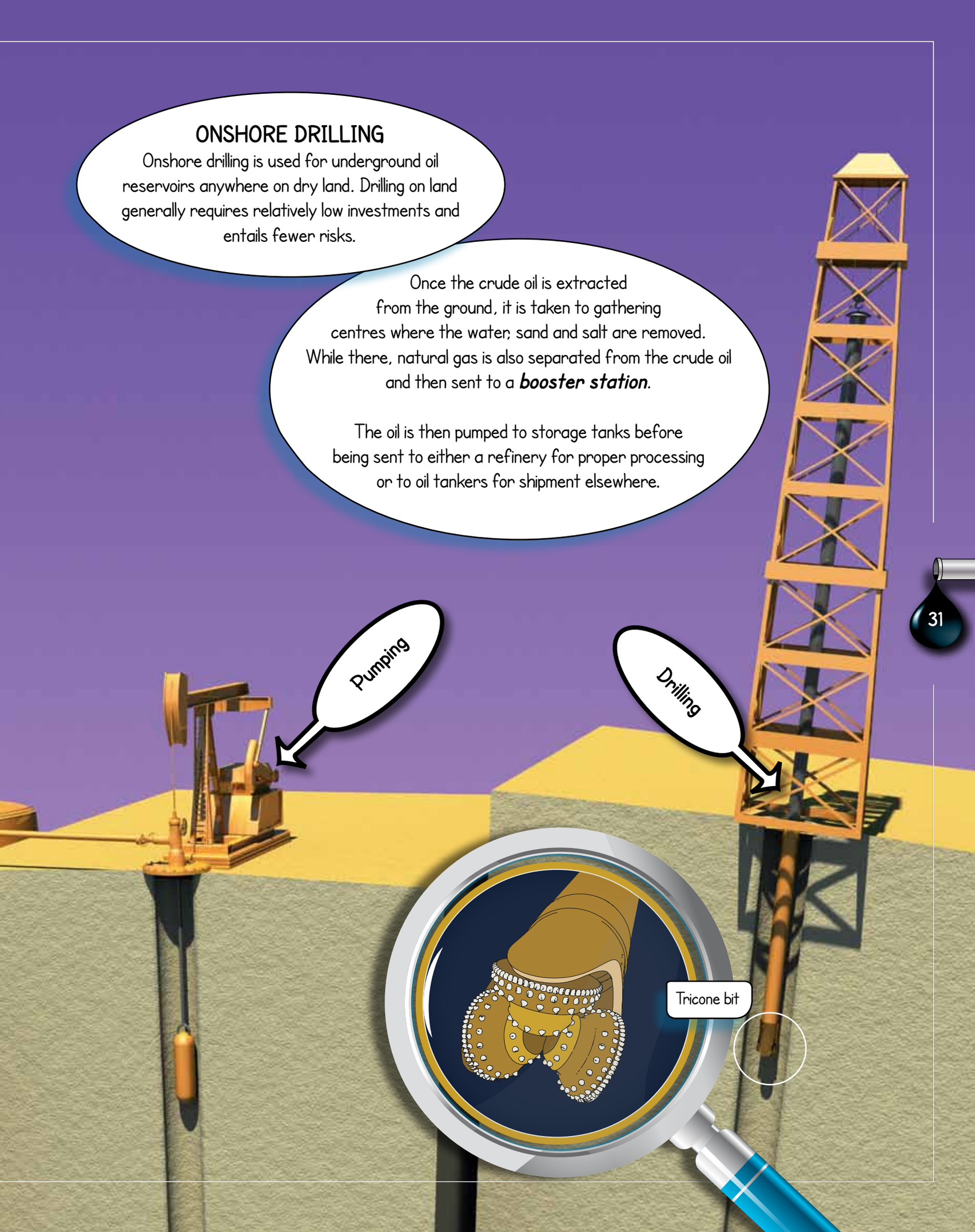


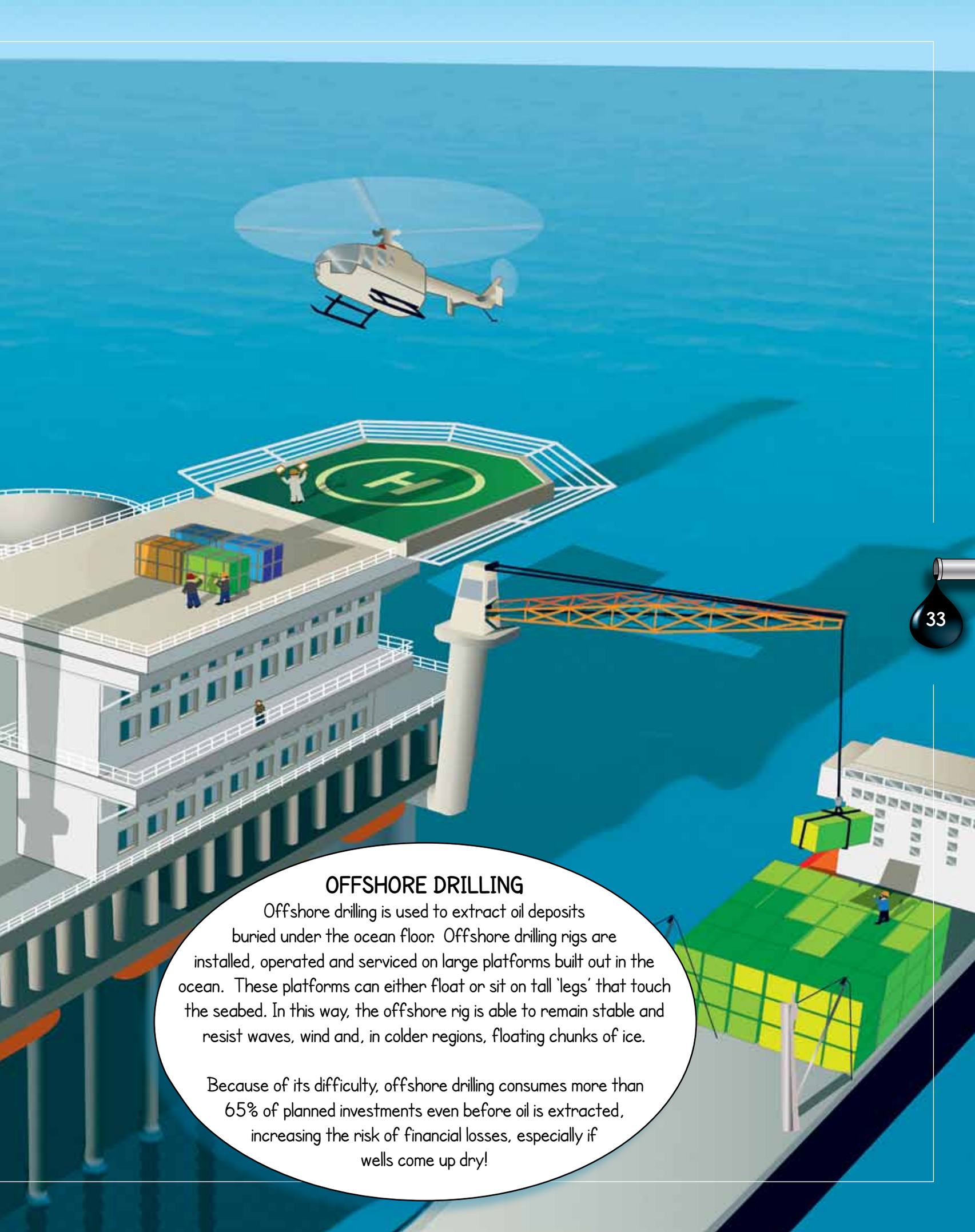
ONSHORE DRILLING

Onshore drilling is used for underground oil reservoirs anywhere on dry land. Drilling on land generally requires relatively low investments and entails fewer risks.

Once the crude oil is extracted from the ground, it is taken to gathering centres where the water, sand and salt are removed. While there, natural gas is also separated from the crude oil and then sent to a ***booster station***.

The oil is then pumped to storage tanks before being sent to either a refinery for proper processing or to oil tankers for shipment elsewhere.





OFFSHORE DRILLING

Offshore drilling is used to extract oil deposits buried under the ocean floor. Offshore drilling rigs are installed, operated and serviced on large platforms built out in the ocean. These platforms can either float or sit on tall 'legs' that touch the seabed. In this way, the offshore rig is able to remain stable and resist waves, wind and, in colder regions, floating chunks of ice.

Because of its difficulty, offshore drilling consumes more than 65% of planned investments even before oil is extracted, increasing the risk of financial losses, especially if wells come up dry!

Huge investments are required

Finding underground oil reservoirs and drilling wells are risky, complicated and expensive activities. The cost of drilling an exploratory oil well can be anything from $1 million to $35 million.

Building and developing a well depends on many factors: the location of the potential oil field (if it is on land or under water), the size of the oil field, the amount of information that is already available and the type of rocks found underground.

That is why an important first step before drilling a well is to obtain information about what is going on thousands of metres below the surface of the Earth. This requires careful exploration and mapping of the 'sub-surfaces' in order to locate the exact type of rocks that tend to have oil deposits. All this requires investments in the latest geographic and seismic technology.

Many oil fields are found in hard-to-reach areas on land or below deep ocean water. New technology is helping oil companies reach these oil fields and increase the amount of oil extracted from the ground. But in order to pay for new technology, hundreds of millions of dollars in investments are needed.

The average amount of time needed to discover, extract and market oil is between 3 to 10 years. But oil explorers also need time to raise the necessary money in order to deal with all the technical challenges.

Much of the time needed depends on the location of the oil field. An offshore oil field in deep water can take much longer to discover and test, especially when the sea bottom is thousands of metres below the surface.