

This book is dedicated to Lydia Rose Makin, who helped research and write some of the Water section, and is one of a new generation of humans helping to look after the elements of our rich and green planet.

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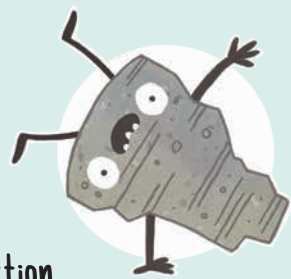


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THE BIG EARTH BOOK

MARK BRAKE *AND* BRENDAN KEARNEY



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This book looks at the history of our planet: how it was formed, what shaped it, and how it came to be full of living things – like you and me! Our planet is a unique and incredible place and has been around for billions of years. So dive into *The Big Earth Book* and take a roller-coaster ride around the most magical place in the whole of the universe.

The book is divided into four chapters – earth, air, fire, and water. These four elements shape our world and through them, we can tell the story of planet Earth in four distinct sections. The ancient Greeks came up with the idea that everything in the world was created by one of these four elements. Although they are important, today we know that the planet and everything on it is actually made up of 118 different chemical elements (like carbon, oxygen, and iron), and they are grouped together in the periodic table of the elements.

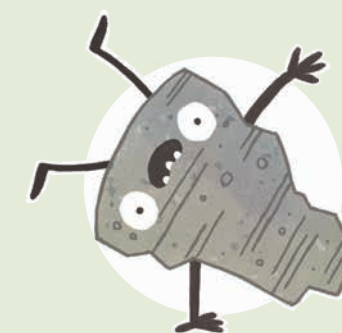
By using the ancient Greek's four classical elements, we can tell a tale about the immense power of our planet. This is a story that uses history, science, geography, and the environment to explain the way our world was made, how we came to exist, and what might happen in the future.



Words in **bold** are further explained in the glossary (pages 248–250).

THE FAB FOUR

Look for these four element characters throughout the book. They will provide you with extra facts and interesting information.

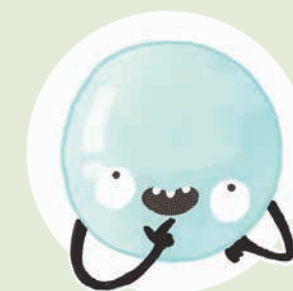


EARTH

THE WORD "EARTH" COMES FROM THE ANGLO-SAXON WORD *ERDA*, AND MEANS "GROUND" OR "SOIL." OUR PLANET IS ALSO CALLED EARTH.

AIR

AIR IS A MIXTURE OF DIFFERENT GASES THAT COVER PLANET EARTH IN A LAYER THAT REACHES UP TO 6,200 MILES (10,000 KILOMETERS) HIGH.



FIRE

FIRE IS A CHEMICAL REACTION THAT CREATES HEAT AND LIGHT. EARTH IS THE ONLY PLANET THAT WE KNOW OF WHERE FIRE EXISTS.



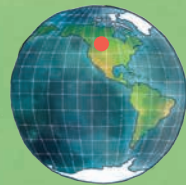
WATER

WATER IS EVERYWHERE! IT COVERS 71 PERCENT OF OUR PLANET. MOST OF IT IS FOUND IN THE SALTY OCEANS, THE REST IS ICE AND FRESH WATER.



EARTHQUAKES

Fault lines are home to a famous and deadly force created by our mighty planet - earthquakes! An earthquake is a vibration that travels through the Earth's crust. They can be triggered by volcanic eruptions and asteroid impacts, but most quakes are caused by movements in the Earth's plates. Convergent and transform plate boundaries push rocks together, causing friction. When the friction builds up, the rocks become locked together, so they no longer slide past each other. The pressure builds up energy until suddenly the rocks give way, snapping forward and shaking the ground. Turn to page 236 to read about how earthquakes can trigger tsunamis.



JANUARY 26, 1700
NORTHWEST COAST
OF NORTH AMERICA

Native Americans living near Vancouver Island tell of how a large community on the coast was entirely wiped out by this earthquake in 1700. Stories also tell how people felt the aftereffects as far away as Japan - on the other side of the Pacific Ocean!

FAMOUS EARTHQUAKES



JANUARY 12, 2010
PORT-AU-PRINCE, HAITI

The main shock was followed by at least 52 aftershocks that continued for 12 days. Aftershocks happen when the initial earthquake passes some of its energy on to nearby rocks, which then start to move and build friction. The quake killed 316,000 people, injured 300,000 people, and left over 1 million people homeless.

MAY 22, 1960
CHILE

The world's most powerful quake struck in southern Chile, killing 4,485 people. A day later, the Puyehue volcano in Chile's lake district spewed ash 19,500 ft. (6,000 m) into the air in an eruption that lasted for several weeks.

NOVEMBER 1, 1755
LISBON, PORTUGAL

The "Great Lisbon Earthquake" almost totally destroyed the Portuguese capital in 1755, and led to the deaths of one-quarter of the city's people. The shock was felt in North Africa, France, and northern Italy, too.



JANUARY 11, 1693
SICILY, ITALY

This huge earthquake is thought to be the most powerful in Italian history. It destroyed more than 70 towns and cities in southern Italy, causing the death of 60,000 people.



EARTHQUAKE ENGINEERING

Engineers today work hard to create modern buildings and bridges that are designed to withstand earthquakes. These structures try to ride the waves of the most fearsome shocks and remain intact once the quaking has stopped. Engineering like this has a long history. The Hagia Sophia in Istanbul, Turkey, was built in AD 537. Twenty years after it was completed, the dome collapsed when an earthquake hit the city. When it was rebuilt, on a smaller scale, builders revised the design to be able to cope with earthquakes, and so the Hagia Sophia still stands to this day.

LIVING ON FAULT LINES

Since the dawn of civilization, people have often set up home by fault lines. This is because the soil in these areas is full of nutrients and is excellent for growing crops. But living by fault lines is dangerous, and there is always the risk of an earthquake happening. Modern societies living on fault lines take time to educate people about what to do if an earthquake hits. In Japan, school children are taught to shelter under their desks and hold on to the legs until the quake is over.



These school children are taking part in an earthquake drill in Japan.

INTO SPACE

The story of human flight doesn't end on Earth. Our mastery of flight has taken us from the air in our atmosphere out into the black of outer space. We've gone one step further than nature's flying creatures! Scientists figured out what was needed to break through the layers of air and out into space: rockets! Space travel involves rocket science, but your rocket doesn't have to be the most complex thing in the world. You could reach space with a rocket the size of a telephone pole just by going really, really fast!

ESCAPE!

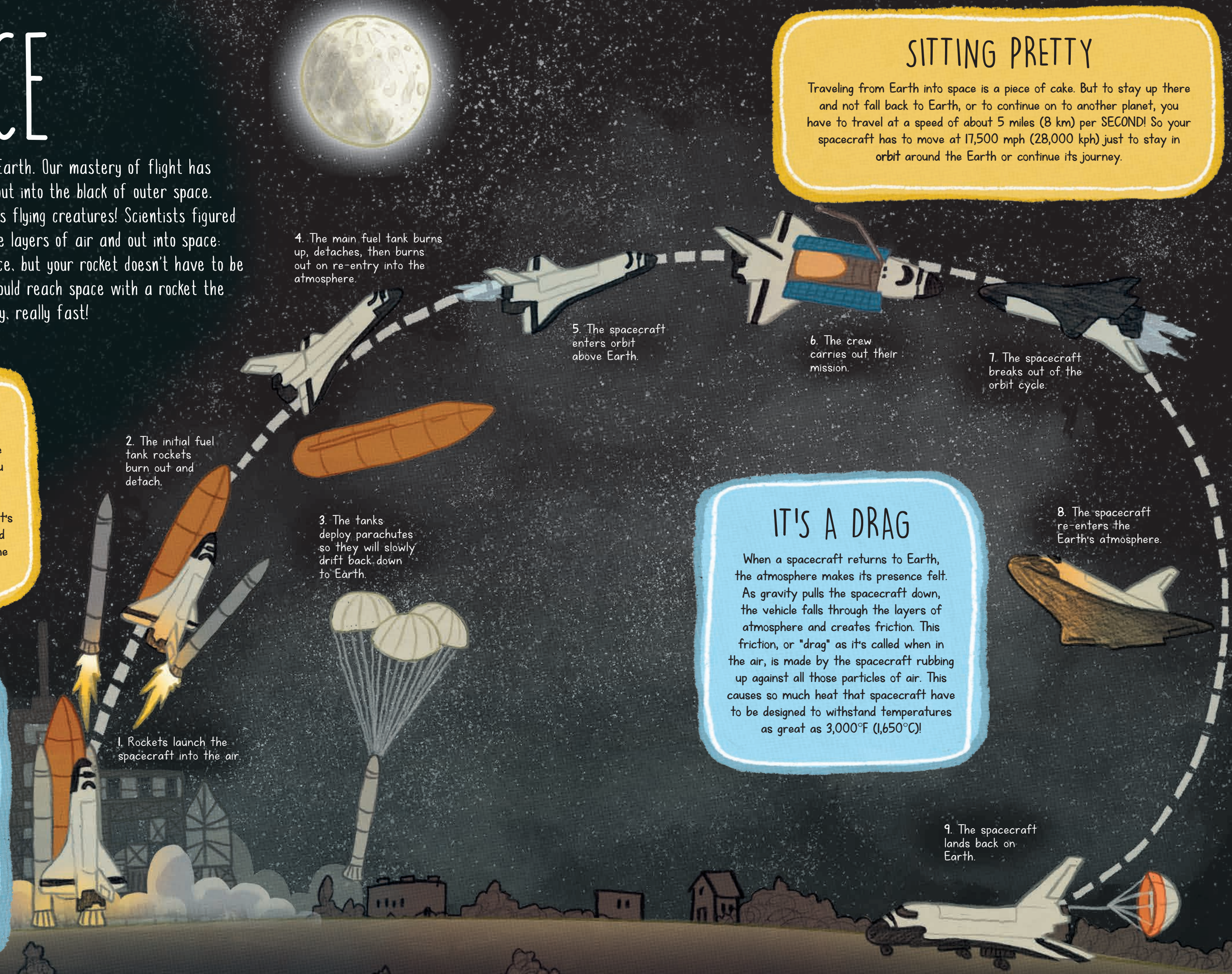
All you need to leave Earth behind you is the right escape speed. That means the speed you need to travel to escape the pull of Earth's gravity. Like most engines, rockets work by burning fuel and converting it into gas. A rocket's engine pushes the gas out of its back end, and this is what creates the thrust that moves the rocket in a certain direction.

JET ENGINE vs. ROCKET ENGINE

A jet engine's fuel can only burn by using oxygen from the air it flies through. But a rocket engine must work in space, where there is no oxygen. So, a rocket must carry its own oxygen. Rockets that use liquid fuel have tanks of liquid oxygen, while solid-fueled rockets carry fuel that contains a chemical with oxygen mixed in.

SITTING PRETTY

Traveling from Earth into space is a piece of cake. But to stay up there and not fall back to Earth, or to continue on to another planet, you have to travel at a speed of about 5 miles (8 km) per SECOND! So your spacecraft has to move at 17,500 mph (28,000 kph) just to stay in orbit around the Earth or continue its journey.



IT'S A DRAG

When a spacecraft returns to Earth, the atmosphere makes its presence felt. As gravity pulls the spacecraft down, the vehicle falls through the layers of atmosphere and creates friction. This friction, or "drag" as it's called when in the air, is made by the spacecraft rubbing up against all those particles of air. This causes so much heat that spacecraft have to be designed to withstand temperatures as great as 3,000°F (1,650°C)!

READING THE AIR

Navigation is the science of planning and directing a journey. On land, it's easy to take a note of your surroundings, but at sea everything looks the same, so it was difficult for early sailors to figure out where they were. Today, navigation at sea works by using positions of latitude and longitude (see pages 220-221), but before that, sailors had to rely on their observations of the stars and weather. The Vikings, who lived from roughly 700 to 1100, were experts at reading the conditions and using their knowledge of them to sail the seas.

AT ONE WITH NATURE

How did the Vikings navigate their way across the water? They observed the wind, weather, and wildlife and were enthusiastic watchers of the sky. The Vikings were fishermen and farmers, so they had a deep understanding of nature. They used the Sun and mapped the position of the stars to track their location. When it was foggy or cloudy, they estimated their location by bird-watching. Some birds never fly far from land, and so recognizing these birds helped Viking sailors figure out if they were close to places they knew.

THE VIKINGS WERE A GROUP OF PEOPLE LIVING IN WHAT IS NOW SCANDINAVIA. THEY WERE SEAFARERS AND SAILED TO NORTHERN AND SOUTHERN EUROPE, AND TO GREENLAND AND NORTH AMERICA.



THE SENSES

Vikings used four of their five senses to help them navigate and pilot their boats. By listening for screeching birds and the sound of waves breaking on the shore, Viking sailors could hear how close they were to land. They used their sense of touch to figure out the direction and speed of the wind as it blew across their faces. They picked up the scent of trees, plants, and even fire from some distance away and so could smell land. Finally, they watched subtle changes in the weather and the clouds above, which helped them identify the wind direction.



FIRST ACROSS THE LINE

The Vikings' navigational know-how in unexplored waters meant they were the first Europeans to visit America. They arrived around the year 1000, beating Christopher Columbus by almost 500 years (see pages 218-219).

THE BAROMETER

Today, a device called a barometer can help us to read the air by measuring air pressure. When air pressure is high, it generally means fair weather. When the pressure is low, it means stormy weather is coming. The first barometer was created in 1644 by an Italian named Evangelista Torricelli.



ALCHEMY

Fire is an incredible tool because it can change one substance into another. It can burn energy trapped in coal and smelt metal from rocks. Fire can also easily destroy an entire forest - that's why our ancestors thought fire was so powerful and believed that fire was the most important of the four elements. As far back as two thousand years ago, some people who were curious about what substances are made of developed alchemy to try and learn how to transform objects and to understand fire's power. Alchemy later developed into the study we call chemistry.

ALCHEMY FACTS

The dawn of alchemy in Europe dates back to around 3500 BC, when people attempted to fire metals and combine them to make new ones. There are also stories of alchemists in India and China who tried to discover the links between fire, gold, and eternal life.

CHEMISTRY OR MAGIC?

The business of ancient alchemists was making ornaments and jewelry out of precious metals like gold. Later, they tried to transform base metals, such as lead, into more precious ones, like gold. Alchemists understood how fire could be used to transform metals, and how to produce colors. In trying to make copper look like gold, they invented brass. In trying to make blue turquoise, they made a blue glaze that was the origin of glass. Over time, alchemy became known as a "black art" because the science behind it was not understood, and people thought the transformations were the result of magic and witchcraft.

THE AIM OF ALCHEMY

The art of alchemy was practiced throughout Europe, Egypt, and Asia. Because the transformation of metals seems magical, alchemists also believed they could make a medicine, or elixir, which would allow the drinker to live forever. In Europe, alchemists tried to create a philosophers' stone, or a "stone of the wise." They believed that such a stone would transform ordinary matter into gold and bring immortal life to the owner.

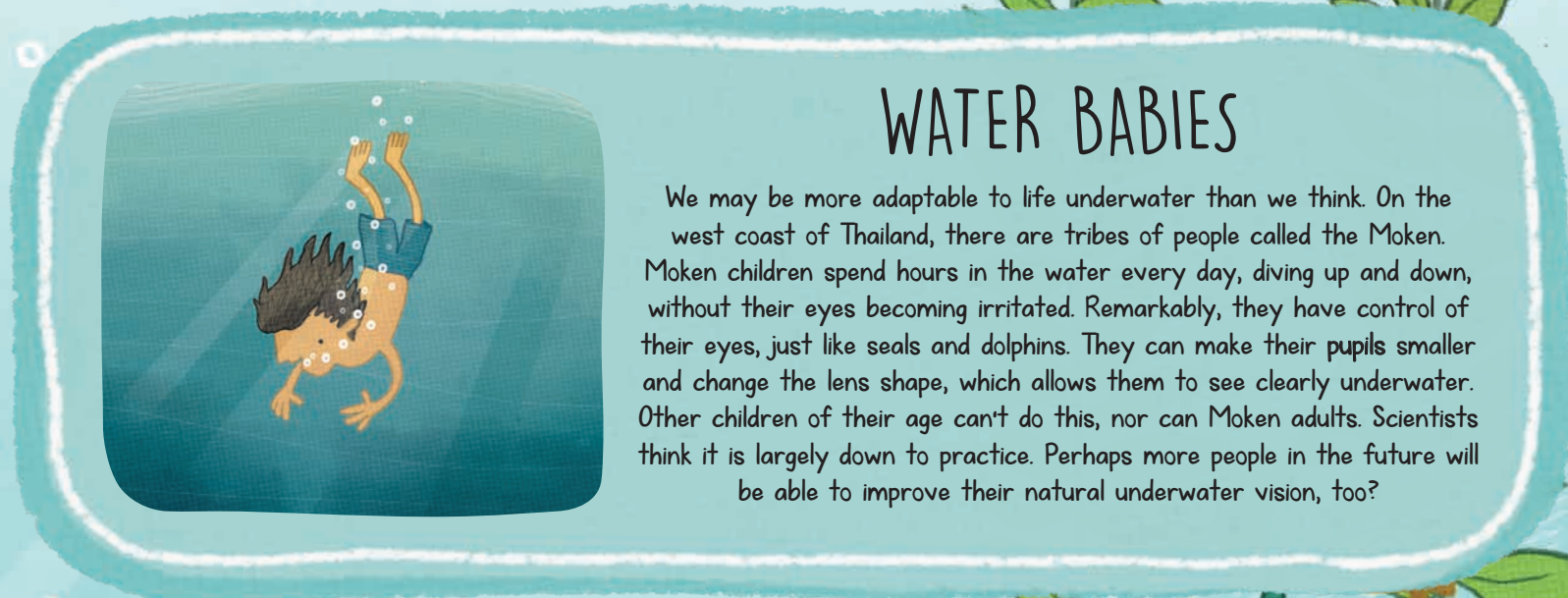
The word "alchemy" comes from the Arabic word 'al-kimiya', meaning "philosopher's stone."

Legend has it that Chinese alchemists were in search of a potion that would bring eternal life, when they discovered black, fiery gunpowder.

The work of alchemists was often written in codes, cyphers, and symbols, which partly explains why modern chemistry uses symbols to this day.

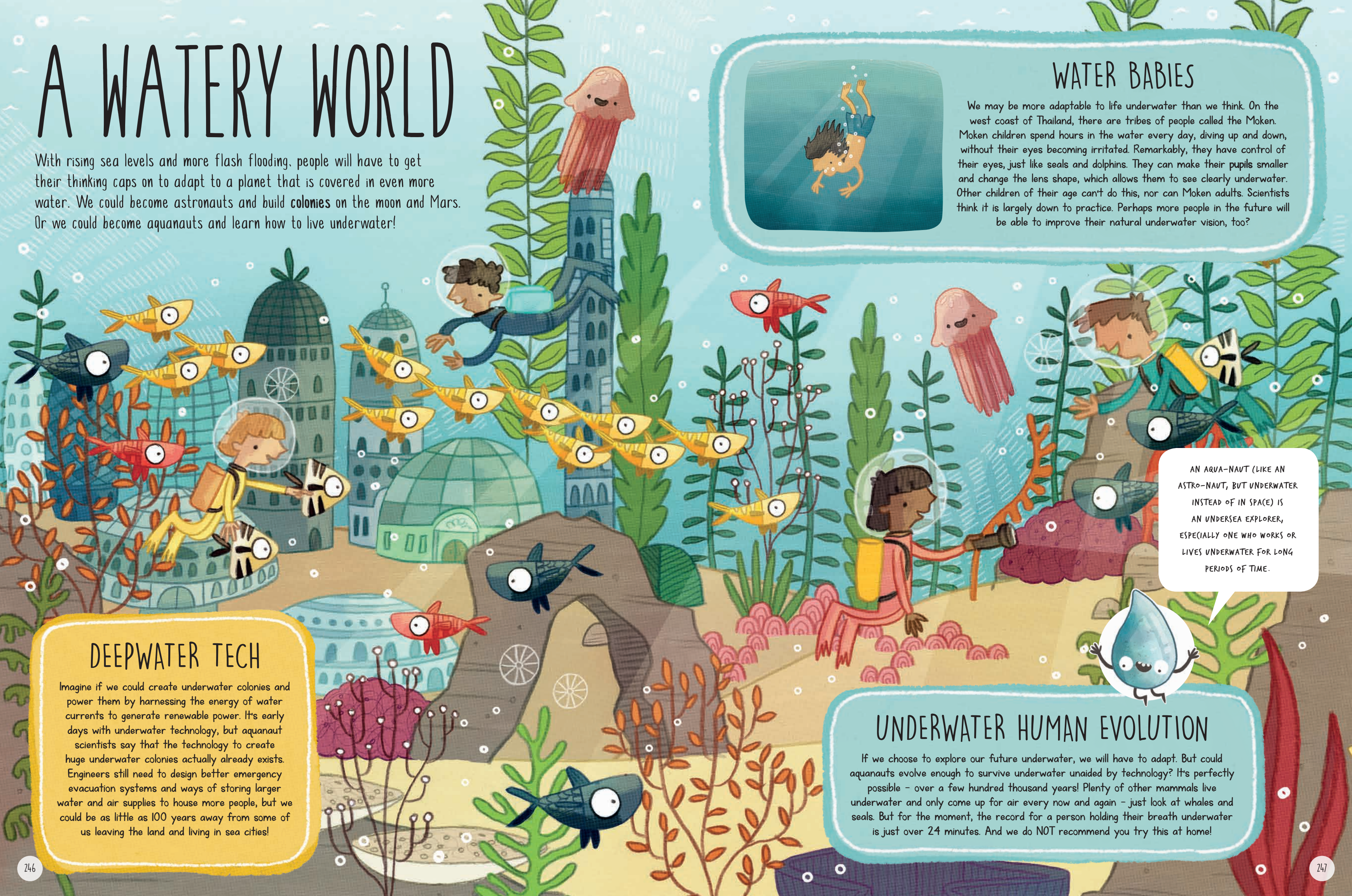
A WATERY WORLD

With rising sea levels and more flash flooding, people will have to get their thinking caps on to adapt to a planet that is covered in even more water. We could become astronauts and build colonies on the moon and Mars. Or we could become aquanauts and learn how to live underwater!



WATER BABIES

We may be more adaptable to life underwater than we think. On the west coast of Thailand, there are tribes of people called the Moken. Moken children spend hours in the water every day, diving up and down, without their eyes becoming irritated. Remarkably, they have control of their eyes, just like seals and dolphins. They can make their pupils smaller and change the lens shape, which allows them to see clearly underwater. Other children of their age can't do this, nor can Moken adults. Scientists think it is largely down to practice. Perhaps more people in the future will be able to improve their natural underwater vision, too?



DEEPWATER TECH

Imagine if we could create underwater colonies and power them by harnessing the energy of water currents to generate renewable power. It's early days with underwater technology, but aquanaut scientists say that the technology to create huge underwater colonies actually already exists. Engineers still need to design better emergency evacuation systems and ways of storing larger water and air supplies to house more people, but we could be as little as 100 years away from some of us leaving the land and living in sea cities!

AN AQUA-NAUT (LIKE AN ASTRO-NAUT, BUT UNDERWATER INSTEAD OF IN SPACE) IS AN UNDERSEA EXPLORER, ESPECIALLY ONE WHO WORKS OR LIVES UNDERWATER FOR LONG PERIODS OF TIME.

UNDERWATER HUMAN EVOLUTION

If we choose to explore our future underwater, we will have to adapt. But could aquanauts evolve enough to survive underwater unaided by technology? It's perfectly possible - over a few hundred thousand years! Plenty of other mammals live underwater and only come up for air every now and again - just look at whales and seals. But for the moment, the record for a person holding their breath underwater is just over 24 minutes. And we do NOT recommend you try this at home!

FURTHER READING

If you'd like to find out more about planet Earth, how life evolved, and the forces that shape our world, then here are some other books you might like to read:

Science Year by Year (Dorling Kindersley)

Packed with fascinating discoveries and facts, this illustrated time line takes you on a fantastic journey through time, from stone tools and simple machines to space travel and robots.

How to Be a Space Explorer (Lonely Planet Kids)

Everything young explorers need to know to travel in space, covering what life in zero gravity is like, how to find your way around the solar system, and the all-important question of how to pee in a space suit!

Dinosaur Atlas (Lonely Planet Kids)

Travel back in time 150 million years. Open gatefolds and flaps to reveal lost prehistoric lands and the dinosaurs that once roamed them. Uncover the latest dinosaur discoveries and fascinating stories about how these ancient creatures lived.

Story of Life: Evolution (Big Picture Press)

A beautifully illustrated fold-out guide to evolution, starting with the first single-celled organisms and ending with modern life forms. Read it as a book or fold it all the way out.

Everything Volcanoes and Earthquakes (National Geographic Kids)

Incredible photos and amazing facts about the awesome powers of nature. Bursting with fascinating information about the biggest volcanic eruptions and earth-shattering earthquakes.

Everything Weather (National Geographic Kids)

Weather can be wild, freaky, and fascinating! Powerful twisters roar through homes; earthquakes shatter whole cities; hurricanes fly through towns. All you need to know about weather and all of its wildness can be found here.

Curious About Fossils (Smithsonian)

Explains why and where fossils form and looks at the colorful lives and important discoveries of some of the great early fossil-hunters, as well as exploring modern fossil exploration and technology.

Eyewitness: Climate Change (Dorling Kindersley)

An in-depth look at global warming - what's causing it, what it might lead to, and what we can do to fight back. With stunning photographs of the dramatic changes that are affecting the weather, the environment, and us.

Ocean: A Children's Encyclopedia (Dorling Kindersley)

From the Arctic to the Caribbean, tiny plankton to giant whales, sandy beaches to the deepest depths, discover the mysterious world beneath the waves. Packed with fun graphics, interesting fact boxes, and high-quality photographs.

The Way Things Work Now (Dorling Kindersley)

A friendly woolly mammoth takes you on an incredible journey through the world of digital technology and explains how everything works.

Destination: Space (Wide Eyed Editions)

Just the thing if you want to explore the stars, planets, and meteors in our galaxy, before launching into deep space and the galaxies beyond our own Milky Way.

What is Evolution? (Wayland)

How did life evolve from simple, single-celled creatures in the sea to the amazingly complex and diverse creatures alive today? This book looks at how evolution has affected everything on Earth over billions of years.

PLACES TO EXPLORE

From science museums, to space centers, here are places you might like to visit. They have interactive experiments and experiences which are the perfect way to find out more. Have fun exploring!

UK

Science Museum, London
(www.sciencemuseum.org.uk)

Natural History Museum, London
(www.nhm.ac.uk)

National Space Centre, Leicester
(www.spacecentre.co.uk)

@Bristol, Bristol
(www.at-bristol.org.uk)

ThinkTank, Birmingham Science Museum, Birmingham
(www.birminghammuseums.org.uk/thinktank)

MAGNA, Rotherham
(www.visitmagna.co.uk/science-adventure)

Eureka, The National Children's Museum, Halifax
(www.eureka.org.uk)

Life Science Centre, Newcastle
(www.life.org.uk)

Glasgow Science Centre, Glasgow
(www.glasgowsciencecentre.org)

Aberdeen Science Centre, Aberdeen
(www.aberdeensciencecentre.org)

Technquest, Cardiff
(www.technquest.org)

W5, Belfast
(www.w5online.co.uk)

Australia

The Australian Museum, Sydney
(www.australianmuseum.net.au)

Sydney Observatory
(www.maas.museum/sydney-observatory)

Powerhouse Museum, Sydney
(www.maas.museum/powerhouse-museum)

Melbourne Museum, Melbourne
(www.museumvictoria.com.au/melbournemuseum)

Questacon, Canberra
(www.questacon.edu.au)

Sciencentre, Queensland Museum, Brisbane, Queensland
(www.sciencentre.qm.qld.gov.au)

US

Liberty Science Center, Jersey City, New Jersey
(www.lsc.org)

Museum of Science & Industry, Chicago, Illinois
(www.msichicago.org)

Exploratorium, San Francisco, California
(www.exploratorium.edu)

Discovery Place Science, Charlotte, North Carolina
(www.discoveryplace.org)

Museum of Science, Boston, Massachusetts
(www.mos.org)

COSI, Columbus, Ohio
(www.cosi.org)

California Science Center, Los Angeles, California
(www.californiasciencecenter.org)

Smithsonian National Air and Space Museum, Washington, DC
(www.airandspace.si.edu)

The Franklin Institute, Philadelphia, Pennsylvania
(www.fi.edu)

California Academy of Sciences, San Francisco
(www.calacademy.org)

The Children's Museum of Indianapolis, Indianapolis, Indiana
(www.childrensmuseum.org)

Maryland Science Center, Baltimore, Maryland
(www.mdsci.org)

Carnegie Science Center, Pittsburgh, Pennsylvania
(www.carnegiesciencecenter.org)

Sci-Port Discovery Center, Shreveport, Louisiana
(www.sciport.org)

St. Louis Science Center, St. Louis, Missouri
(www.slscc.org)

American Museum of Natural History, New York
(www.amnh.org)

Fernbank Museum of Natural History (www.fernbankmuseum.org) and Fernbank Science Center (www.fernbank.edu),

Pacific Science Center, Seattle, Washington
(www.pacificsciencecenter.org)

Science Museum of Minnesota, St Paul, Minnesota (www.smm.org)

Gulf Coast Exploreum Science Center, Mobile, Alabama (www.exploreum.com)

Union Station, Kansas City, Missouri
(www.unionstation.org/sciencecity)

Montshire Museum of Science, Norwich, Vermont (www.montshire.org)

The Discovery Science Place, Tyler, Texas (www.discoveryscienceplace.org)

Museum of Discovery and Science, Fort Lauderdale, Florida (www.mods.org)

OMSI, Portland, Oregon (www.oms.edu)

Arizona Science Center, Phoenix, Arizona (azscience.org)

