

# GEOGRAPHY

FOR EDEXCEL  
A LEVEL YEAR 2

This book is endorsed for the Pearson Edexcel GCE Geography A Level specification. It provides:

- ◆ engaging content for A Level
- ◆ a stimulating approach that enables students to engage with real-world issues and places
- ◆ exam-style questions and support for skills and fieldwork

## 2.2 The carbon cycle

In this section, you'll learn that most global carbon is locked up in terrestrial stores as part of the long-term geological cycle.

EQ! Sections 2.2 to 2.4 investigate how the carbon cycle operates to maintain planetary health.

### Understanding carbon

Carbon provides the major building blocks for all life on Earth. It regulates our climate, making it warm enough to survive, and is stored within rocks, plants and the oceans.

- ◆ **Stores** of carbon are also referred to as **pools, stocks and reservoirs**.
- ◆ There are **terrestrial, oceanic and atmospheric** stores.
- ◆ **Flux** refers to the **movement or transfer** of carbon between stores. Fluxes create cycles and feedbacks.

Human activity is part of the carbon cycle, and planetary health is placed at risk as more carbon enters the atmosphere. However, the amounts added by human activity are tiny compared with the flows that are exchanged naturally between oceans, land and atmosphere every day.

### The geological carbon cycle

The geological carbon cycle (see Figure 1) is a natural cycle that moves carbon between land, oceans and atmosphere. This movement involves a number of chemical reactions that create new stores which trap carbon for significant periods of time. There tends to be a natural balance between carbon production and absorption within this cycle. However, there can be occasional disruptions and short periods before the equilibrium is restored, such as when major volcanic eruptions emit large quantities of carbon into the atmosphere, or when natural climate changes occur.

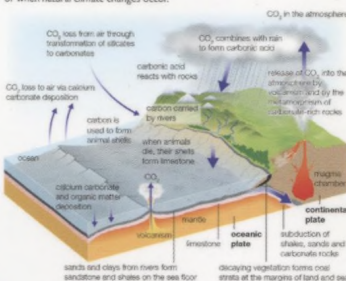
### KEY CONCEPTS

- ◆ **Systems** – how the carbon cycle operates with inputs, stores, flows and outputs
- ◆ **Equilibrium** – how the carbon cycle is maintained in a balance

Figure 1 shows six important natural stores and fluxes:

- 1 Terrestrial carbon, held within the mantle, is released into the atmosphere as carbon dioxide (CO<sub>2</sub>) when volcanoes erupt (see Figure 2). This is known as **out-gassing**.
- 2 CO<sub>2</sub> within the atmosphere combines with rainfall to produce a weak acid (carbonic acid, also known as acid rain) that dissolves carbon-rich rocks, releasing bicarbonates. This is **chemical weathering**.
- 3 Rivers transport weathered carbon and calcium sediments to the oceans, where they are deposited.
- 4 Carbon in **organic matter** from plants and from **animal shells and skeletons** sinks to the ocean bed when they die, building up strata of coal, chalk and limestone.
- 5 Carbon-rich rocks are subducted along plate boundaries and eventually emerge again when volcanoes erupt.
- 6 The presence of intense heating along subduction plate boundaries metamorphoses (or alters) sedimentary rocks by heating, creating **metamorphic rocks**. CO<sub>2</sub> is released by the metamorphism of rocks rich in carbonates during this process.

Figure 1 The geological carbon cycle



## 2 The carbon cycle and energy security

The carbon cycle illustrated in Figure 1 contains two types of carbon: geological and biologically derived. **Geological carbon** results from the formation of sedimentary carbonate rocks – limestone and chalk – in the oceans, and **biologically derived carbon** is stored in shale, coal and other sedimentary rocks.

### Maintaining an equilibrium

The impact of emissions from volcanic eruptions is to send extra CO<sub>2</sub> into the atmosphere, which leads to rising temperatures, increased evaporation and higher levels of atmospheric moisture. This, in turn, leads to increased acid rain, which weathers rocks and creates bicarbonates that will eventually be deposited as carbon on the ocean floor. The process is slow – perhaps a few hundred thousand years – but this **chemical weathering** process slowly rebalances the carbon cycle.

### The bio-geochemical carbon cycle

Biological and chemical processes determine just how much of the carbon available on the Earth's surface is stored or released at any one time. That's why it's often referred to as the **bio-geochemical carbon cycle**. The role of living organisms is critical in maintaining the efficient running of this system, because they control the overall balance between storage, release, transfer and absorption.

As Figure 3 shows, the four key processes in the cycle are:

- ◆ **photosynthesis** – removing CO<sub>2</sub> from the atmosphere to promote plant growth
- ◆ **respiration** – releasing CO<sub>2</sub> into the atmosphere as animals consume plant growth and breathe
- ◆ **decomposition** – breaking down organic matter and releasing CO<sub>2</sub> into soils
- ◆ **combustion of biomass and fossil fuels** – releasing CO<sub>2</sub> and other greenhouse gases into the atmosphere.

Together, these four processes continuously transfer carbon from one store to another. The time period over which the carbon stays in any one store is important, and – since the Industrial Revolution – deeply buried stores of carbon have been exploited and burnt, releasing CO<sub>2</sub> into the atmosphere. Figure 3 shows the bio-geochemical cycle and the enhanced flow of CO<sub>2</sub> from the geosphere (i.e. the Earth) to the atmosphere as a result of combustion caused by human activities.



In 2010, the Eyjafjallajökull volcano in Iceland erupted – emitting CO<sub>2</sub> into the atmosphere, plus extensive ash clouds that spread across Europe. The eruption emitted between 150 000 and 300 000 tonnes of CO<sub>2</sub> per day – placing it in the same emissions league as small-to-medium-sized European countries such as Portugal or Ireland. But it contributed less than 0.3% of global emissions of greenhouse gases in 2010.

Figure 2 Eyjafjallajökull in Iceland erupted April 2010, sending ash and carbon dioxide into the atmosphere

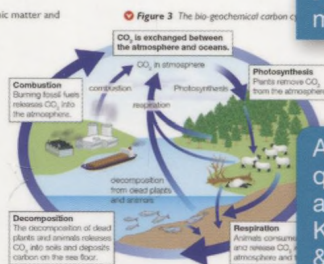


Figure 3 The bio-geochemical carbon cycle

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