Chapter 9 Lakes

L Titicaca – highest
Caspian Sea – largest
L Tanganyika – deepest
Dead Sea – lowest
} Tectonic
} Rift valley
} lakes formed by Earth movements

General

Lakes are amongst the most varied features of the earth's surface. They occupy the hollows of the land surface in which water accumulates. They vary tremendously in size, shape, depth and mode of formation. The tiny ones are no bigger than ponds or pools, but the large ones are so extensive that they merit the name of seas, e.g. the Caspian Sea which is 760 miles long, as much as 3,215 feet deep, with a total area of 143,550 square miles, and is bigger than the whole of Malaysia!

Lakes may exist *temporarily* filling up the small depressions of undulating ground after a heavy shower. But those which are deep and carry more water than could ever be evaporated remain *permanent*. Most of the lakes in the world are *freshwater lakes* fed by rivers and with out-flowing streams e.g. Lake Geneva, Lake Poyang and the Great Lakes of North America. In regions of low precipitation and intense evaporation where there are few rivers strong enough to reach the sea, streams drain into a lake forming a basin of *inland drainage*. Because of the intense evaporation these lakes are saline. For example the Dead Sea has a salinity (salt content) of 250 parts per thousand, and the Great Salt Lake of Utah, U.S.A. has a salinity of 220 parts per thousand. But, the Black Sea, into which drain many large rivers, has a salinity of less than 17 parts per thousand! *Playas* or salt lakes, are a common feature of deserts.

It must be pointed out that lakes are only temporary features of the earth's crust; they will eventually be eliminated by the double process of draining and silting up. In regions of unreliable rainfall, lakes dry up completely during the dry season. In the hot deserts lakes disappear altogether by the combined processes of evaporation, percolation and outflow. Though the process of lake elimination may not be completed within our span of life, it takes place relatively quickly in terms of geological time.

The Formation and Origin of Lakes

The following are the various ways in which lakes can be formed. Each of them is placed in a specific category, though in a few cases the lakes could have been formed by more than one single factor.

1. Lakes Formed by Earth Movement

(a) Tectonic lakes. Due to the warping, sagging, bending and fracturing of the earth's crust, tectonic depressions occur. Such depressions give rise to lakes of immense sizes and depths. They include Lake Titicaca, occupying a huge depression in the intermont plateau of the Andes, 12,500 feet above sea level the highest lake in the world; and the Caspian Sea, 143,550 square miles, the largest lake, almost 5 times larger than its nearest rival, Lake Superior.

(b) Rift valley lakes. Due to faulting, a rift valley is formed by the sinking of land between two parallel faults, deep, narrow and elongated in character. Water collects in these troughs and their floors are often below sea level. The best known example is the East African Rift Valley which runs through Zambia, Malawi, Tanzania, Kenya and Ethiopia, and extends along the Red Sea to Israel and Jordan over a total distance of 3,000 miles. It includes such lakes as Lakes Tanganyika (4,700 feet deep, the world's deepest lake), Malawi, Rudolf, Edward, Albert, as well as the Dead Sea 1,286 feet below mean sea level, the world's lowest lake (Fig. 67).

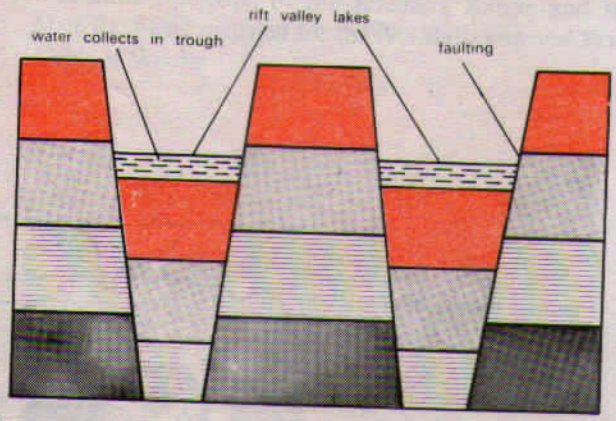
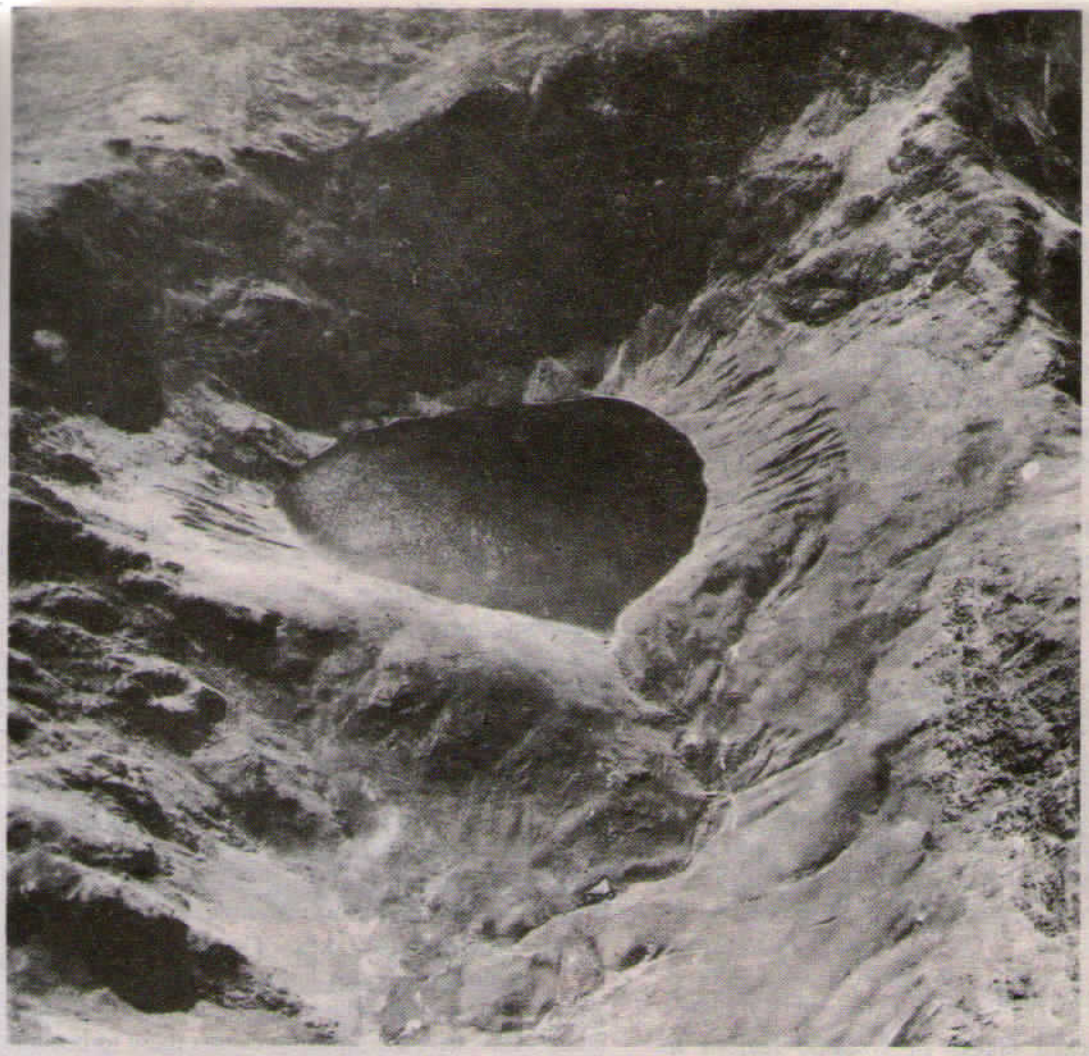


Fig. 67 Earth movement

2. Lakes Formed by Glaciation

(a) Cirque lakes or tarns. A glacier on its way down the valley leaves behind circular hollows in the heads of the valleys up in the mountains. Such hollows are the arm-chair-shaped cirques or corries. Their over-deepened floors may be filled with water to become cirque lakes e.g. Red Tarn in the English Lake District (Fig. 68). Those that occupy glacial troughs are long and deep and are termed ribbon lakes, e.g. Lake Ullswater.

(b) Kettle lakes. These are depressions in the



Blea Water in Westmorland, England, a typical corrie lake
J.K. St. Joseph

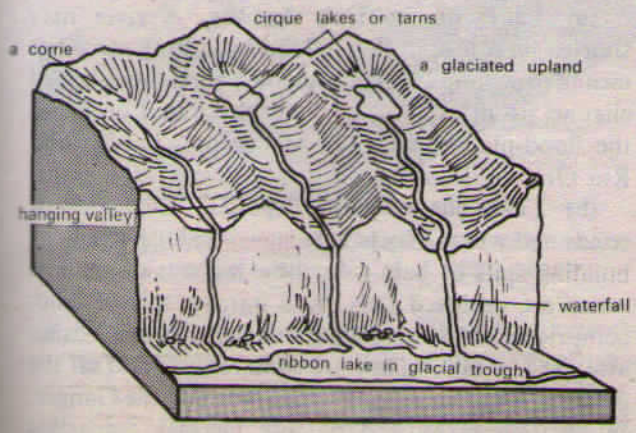


Fig. 68 Glaciation

outwash plain left by the melting of masses of stagnant ice. They are irregular because of the uneven morainic surface and are never of any great size or depth e.g. the meres of Shropshire in England, and the kettle-lakes of Orkney in Scotland.

(c) Rock-hollow lakes. These are formed by ice-scouring when valley glaciers or ice sheets scoop out hollows on the surface. Such lakes of glacial origin are abundant in Finland, indeed the Finns call their country *Suomi* — the Land of Lakes. It is said that there are over 35,000 glacial lakes in Finland!

(d) Lakes due to morainic damming of valleys. Valley glaciers often deposit morainic debris across a valley so that lakes are formed when water accumulates behind the barrier. Both lateral and terminal moraines are capable of damming valleys e.g. Lake Windermere of the Lake District, England.

(e) Lakes due to the deposition of glacial drifts. In glaciated lowlands with a predominant drumlin landscape, where drainage is poor, there are intervening depressions. These depressions are often water-logged, forming small lakes like those of County Down in Northern Ireland.

3. Lakes Formed by Volcanic Activity

(a) Crater and caldera lakes. During a volcanic explosion the top of the cone may be blown off leaving behind a natural hollow called a *crater*. This may be enlarged by subsidence into a *caldera*. These depressions are normally dry, bounded by steep cliffs and roughly circular in shape. In dormant or extinct volcanoes, rain falls straight into the crater or caldera which has no superficial outlet and forms a crater or caldera lake. The outstanding ones are the Crater Lake in Oregon, U.S.A. which in fact occupies a caldera; Lake Toba in northern Sumatra and Lake Avernus near Naples (Fig. 69).

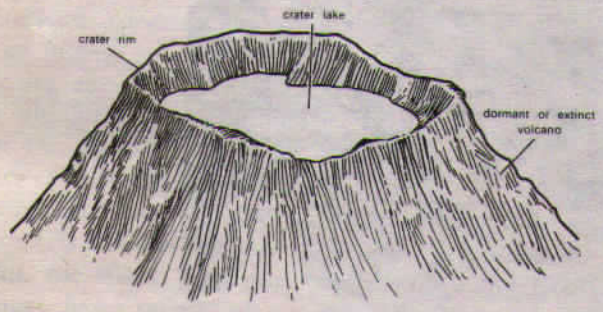


Fig. 69 Volcanic activity

(b) Lava-blocked lakes. In volcanic regions a stream of lava may flow across a valley, become solidified and thus dam the river forming a lake, e.g. a lava flow blocks the Jordan valley forming the Sea of Galilee which is an inland lake, rather elongated in shape.

(c) Lakes due to subsidence of a volcanic land surface. The crust of a hollow lava flow may collapse The subsidence leaves behind a wide and shallow depression in which a lake may form, e.g. Myvatn of Iceland.

4. Lakes Formed by Erosion

(a) Karst lakes. The solvent action of rain-water on limestone carves out solution hollows. When these become clogged with debris lakes may form in them. The collapse of limestone roofs of underground caverns may result in the exposure of long, narrow lakes that were once underground e.g. the Lac de Chaillexon in the Jura Mountains.

The large depressions called poljes, which normally

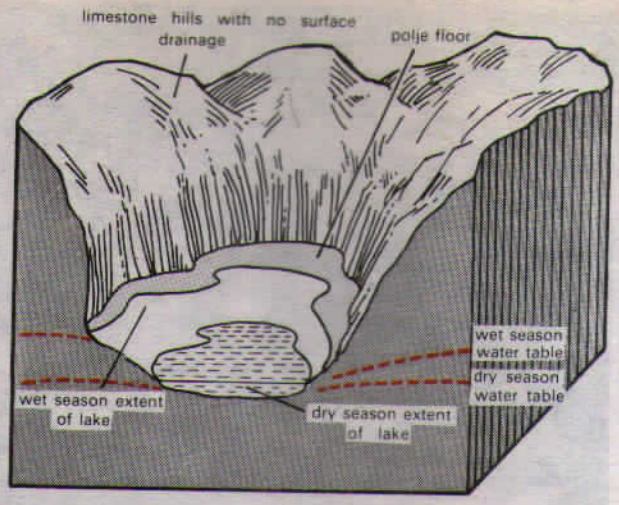


Fig. 70 A karst lake formed above the ground water table in a limestone region.

do not have surface outlets, may contain lakes. During wet periods these may cover most of the polje floor but they shrink during dry periods due to seepage (Fig. 70). An example is Lake Scutari in Yugoslavia.

Solution is important in other rocks such as rock salt. Local subsidence may occur when the underlying beds of rock-salt are gradually removed in solution. Many of the meres of Cheshire, England, were probably caused by this, and are also the result of salt-mining operations.

(b) Wind-deflated lakes. The deflating action of winds in deserts creates hollows. These may reach ground water which seeps out forming small, shallow lakes. Excessive evaporation causes these to become salt lakes and playas. These are found in the Qattara Depression in Egypt, and the Great Basin of Utah, U.S.A.

5. Lakes Formed by Deposition

(a) Lakes due to river deposits. A river may shorten its course during a flood by cutting across its meandering loops, leaving behind a horseshoe-shaped channel as an ox-bow lake, e.g. those that occur on the flood-plains of Lower Mississippi, U.S.A. and Rio Grande, Mexico.

(b) Lakes due to Marine deposits. The action of winds and waves may isolate lagoons along coasts by building spits or bars. As these lagoons of shallow water are enclosed only by a narrow spit of land, comprising mud, sand and shingle, they may drain away at low tide. They are commonly found off the deltas of large rivers such as the Nile and the Ganges. In East Germany and Poland, lagoons are called haffs. Strong on-shore winds are capable of pushing

coastal sand dunes landwards, and these may enclose marshy lagoons. This type of lagoon is well developed in the Landes of south-west France.

(c) Lakes due to landslides, screes and avalanches. Lakes formed by these processes are also known as barrier lakes. Landslides or screes may block valleys so that rivers are dammed. Such lakes are short-lived, because the loose fragments that pile across the valleys will soon give way under the pressure of water. When they suddenly give way, the dammed water rushes down, causing floods. Examples of lakes of this type are, Lake Gormire in Yorkshire, blocked by landslides; Ffynnon Frech on Snowdon blocked by screes (Fig. 71).

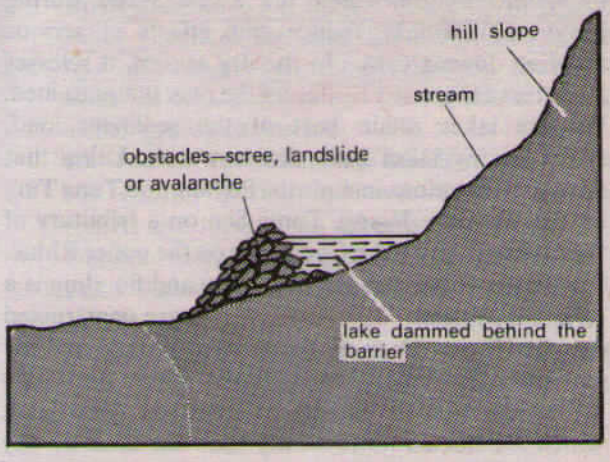


Fig. 71 Deposition (a barrier lake formed by the deposition of an obstacle)

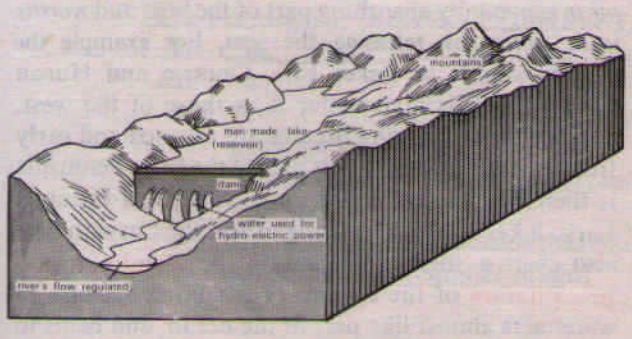


Fig. 72 Human activities (a lake made by constructing a concrete dam across a river valley)

6. Lakes Formed by Human and Biological Activities

(a) Man-made lakes. Besides the natural lakes, man has now created artificial lakes by erecting a *concrete dam* across a river valley so that the river water can be kept back to form reservoirs (Fig. 72). Amongst such man-made lakes, the most imposing is Lake Mead above the Hoover Dam on the Colorado River, U.S.A.

(b) Lakes made by animals. Animals like beavers are particularly interesting. They live in communities and construct dams across the rivers with timber. Such beaver dams are quite permanent and are found in North America, e.g. Beaver Lake in Yellowstone National Park, U.S.A.

(c) Other types of lakes. These include ornamental lakes, especially made to attract tourists, e.g. Lake Gardens, Kuala Lumpur, Taiping Lakes. Man's mining activities, e.g. tin mining in West Malaysia, have created numerous lakes. Inland fish culture has necessitated the creation of many *fishing-lakes*.

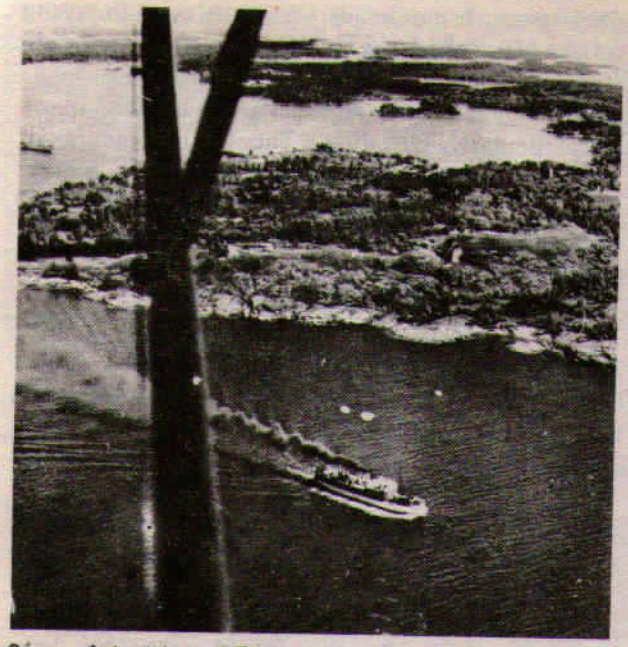
Lakes and Man

A careful examination of the lakes of the world will reveal their immense human significance. In countries where they are found in abundance, such as Finland, Canada, U.S.A., Sweden and the East African states, lakes, together with other inland waterways, have played a dominant role in the human, economic, social and cultural life of the people. The pattern of settlement, commerce and communication is very closely related to the distribution of the water features.

The following are the major uses of lakes and their associated human activities.

1. Means of communication. Large lakes like the Great Lakes of North America provide a cheap and convenient form of transport for heavy and bulky goods such as coal, iron, machinery, grains and timber. The Great Lakes-St. Lawrence waterways penetrate more than 1,700 miles into the interior. They are thus used as the chief arteries of commerce. It is estimated that the annual tonnage passing through the Sault-Ste. Marie Canal, or the Soo Canal, between Lake Huron and Lake Superior is greater than the combined annual tonnage of the Suez and Panama Canals.

2. Economic and industrial development. Early settlements and town sites were very much influenced by the presence of lakes. Lakes are an even more decisive factor when they are drained by large rivers with outlets to the sea. The Great Lakes-St. Lawrence waterways were responsible for the development of the interior wheat farms and lakeside industries. Raw materials, minerals and fuels were economically handled and assembled in the '*HOMES*' district (Lakes *H*uron, *O*ntario, *M*ichigan, *E*rie and *S*uperior), which has since become one of the greatest industrial districts of the world. Similarly, Lakes Poyang, Tung Ting and other lakes of the central



Some of the lakes of Finland scoured out by ice action
Camera Press

Yang-tze basin have greatly assisted in the commercial and industrial development of *Wuhan* (*Wu*chang, *Han*yang and *Han*kow).

3. Water storage. Lakes of either natural or artificial origin are vital sources of *domestic* water supply to surrounding towns and industrial cities. For example in Britain Lake Thirlmere supplies water to Manchester, Loch Katrine to Glasgow, Lake Vyrnwy (in Wales) to Liverpool. The Okhla Reservoir supplies Delhi and the Vetarna, Vihar and Tulsi lakes supply Bombay.

4. Hydro-electric power generation. In mountainous districts, lakes or man-made reservoirs are used to furnish *a good* head of water to generate hydro-electric power. Natural lakes are preferred to artificial reservoirs because the volume of water that flows from them varies very little throughout the year. For instance, the Niagara River flowing from Lake Erie to Lake Ontario has a very regular supply of water for its power stations, whereas the Catawba River in the Carolinas which does not flow from a lake, has very little water during the dry season. Cotton mills have been forced to close down during the period of drought due to insufficient power supplies to run the mills. The Aswan Dam on the Nile in Egypt and the Lloyd Barrage on the Indus at Sukkur suffer from similar defects. The Abu Bakar Dam of the Cameron Highlands supplies much hydro-electricity for central West Malaysia.

5. Agricultural purposes. As mentioned earlier most lakes will eventually be eliminated, and when they dry up, their former beds are covered with thick layers of fertile alluvium. They make excellent agricultural land like the fertile Vale of Pickering in Yorkshire, or the rich Red River Valley of Canada which was in fact the former site of Lake Agassiz.

Modern multi-purpose dams, besides generating hydro-electric power also supply water for irrigation e.g. the Sennar Dam on the Blue Nile in Sudan, the Burrinjuck Dam on the Murrumbidgee in Australia, and the Hirakud Dam (Madhya Pradesh) on the Mahanadi in India.

6. Regulating river flows. A river with large lakes in its basin seldom experiences serious floods or lack of water. By absorbing the excess water during heavy rain, a lake reduces the effects of serious flooding downstream. In the dry season, it releases its water so that a steady flow of the river is maintained. Because lakes retain part of the sediment load, rivers leaving lakes have clearer water. Lakes that have such functions include the Poyang and Tung Ting on the Yang-tze Kiang, Tonle Sap on a tributary of the Mekong, and Lake Constance on the upper Rhine. Where such lakes are not available, and flooding is a serious problem, artificial reservoirs are constructed e.g. the Hoover Dam on the River Colorado and the Bhakra and Nangal Dams on the Sutlej in India.

7. Moderation of climate. Large and deep lakes which are heated more slowly than the land by day and cooled more slowly than the land by night, exercise an appreciable effect in moderating the climate of a region in the same way as oceans affect adjoining land masses. Water in the lakes *cools the air in summer* by absorbing part of the heat and *warms it in winter* by releasing the heat. For example the eastern shores of Lakes Erie, Ontario and Huron have a much milder winter than those of the west, because the on-coming breezes are warmed and early frosts are minimised. This part of the Lake Peninsula is therefore important for grapes and fruit farming. Large lakes like Lake Michigan and the Caspian Sea, also exert a slight influence on the cloudiness and precipitation of the region. Their large expanse of water acts almost like part of the ocean, and helps to precipitate atmospheric moisture into rain. The leeward side of Lake Michigan records a little more precipitation than the windward side, though the actual amount is often not easily noticeable. Small lakes have practically no effect at all on either temperature or rainfall.

8. Source of food. Many large lakes have important supplies of protein food in the form of freshwater

fish. Sturgeon is commercially caught in the Caspian Sea, salmon and sea trout in the Great Lakes, and in Tonle Sap in Cambodia, fishing is a leading occupation. Amateur fishermen have found fishing in lakes and rivers a most rewarding pastime. In many countries, artificial lakes have been created for inland fish breeding. This is particularly important in China and Japan.

9. Source of minerals. Salt lakes provide valuable rock salts. In the Dead Sea, the highly saline water is being evaporated and produces common salt, almost indispensable for human well-being. Borax is mined in the salt lakes of the Mojave Desert.

Gypsum is mined in Cheshire, and Stassfurt, a small distance from Berlin, is so rich in potash and other chemical deposits, that they have given rise to a wide range of chemical industires. In both these areas the salts are obtained from deposits formed in a earlier geological period.

10. Tourist attraction and health resorts. Some of the world's best frequented holiday and health resorts are located on lakesides for example, Lake Geneva, Lake Lucerne, Lake Lugano, Lake Como, Lake Placid (New York), Lake Vaner and Lake Vatter, (Sweden), the English Lake District and Taiping Lakes. The glacier-formed lakes of the Alps have made the tourist industry a national occupation of the Swiss.

QUESTIONS AND EXERCISES

1. Locate any *three* of the following lakes. Lake Tanganyika, Great Salt Lake, Lake Toba, Lake Como, Lake Victoria, Lake Scutari, Lake Mead
   (a) With the aid of sketch maps, explain their mode of formation
   (b) State their specific value to the countries they serve
   (c) Name another lake outside that country which has fairly similar origins

2. Explain how each of the following types of lakes are formed. Quote an example of each and locate them in clear sketch maps.
   (a) ox-bow lake
   (b) kettle lake
   (c) crater lake
   (d) karst lake

3. (a) With the help of large, labelled diagrams, explain how lakes may be formed by any *three* of the following.
      i. glaciation
      ii. earth movement
      iii. volcanic activity
      iv. erosion
      v. deposition
   (b) Quote three actual examples of each
   (c) State three uses of man-made lakes

4. Rivers may be dammed for
   (a) generating hydro-electricity
   (b) controlling floods
   (c) irrigating crops
   (d) supplying drinking water
   (e) assisting inland water transport

   For any *four* of them, locate a dam and a river in which the damming has taken place. Explain briefly how each of the above purposes has been successfully achieved.

5. Each of the following terms are in one way or another connected with lake formation and uses. For any *five* of them give a concise explanation of their implications and give a good example of each.
   (a) basin of inland drainage
   (b) tectonic lakes
   (c) haffs
   (d) beaver dams
   (e) playas
   (f) barrier lakes
   (g) tarns