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MINING IN CANADA

CANADA covers the northern half of the North American continent, having an area of 3,729,665 square miles. About 700,000 square miles of this great area are covered with rich fertile soil, 900,000 square miles with forest, and 120,000 square miles with lake, etc., while over about 200,000 square miles the surface is buried under a thick blanket of moss. The remainder of the country, as well as some of the forested area, is rocky, and a study of how this rocky country should best be utilized for the benefit of mankind, is one of the greatest research problems of this age, a problem beside which most of those undertaken in our small laboratories dwarfs into insignificance.

The prospector and miner are the men who at the present time are doing most to work out the solution of this problem. In their work they have been assisted for the past eighty years by the Geological Survey of Canada, one of the earliest scientific research bureaus to be established on this Continent, and also, but in later years, by the Geological and Mining Bureaus of the various provinces.

In the 16th century when the gold and silver mines of South America and Mexico were attracting the attention of many of the leading men of the different nations of Europe, Canada did not entirely escape attention, for in 1576, three years after the rich gold mines of Minas Geraes of Brazil had been discovered, Martin Frobisher, one of the great sailors of the "Elizabethan Era," sailed from the Port of London in search of a northwest passage north of the Continent of America to Asia, where fabulous stores of metallic riches were believed to exist. He did not get half way to his destination, but was stopped by ice in a bay on the east side of Baffin Island, whence he returned to England. After his return a

[1] Address of the president and vice-president of Section M, American Association for the Advancement of Science, December, 1922.

piece of black rock which he brought back with him, was drawn to the attention of the "gold finers" of London, who reported that it contained a considerable quantity of gold. In the following year, after receiving direct instructions and encouragement from Queen Elizabeth, he started back with three ships to look for more of this gold, having several "gold finers" with him. His ships were not of the class that we are accustomed to think of as crossing the Atlantic at the present day, for while one was of 180 tons, the other two were of about 30 tons each. After arriving at their destination, since known as Frobisher Bay, they labored hard for twenty days and loaded 200 tons of "ore," which they took back with them to England. Most of this "ore" was stored in Bristol Castle and the rest in the Tower of London. Samples were given out from time to time, but the returns on these samples seem to have been very contradictory. One assayer, who had been with Frobisher, and who had directed the "mining," claimed that if properly "treated and coaxed" it would yield £40 to the ton, while most of the goldsmiths of London said that they could not find any gold in it at all. Nevertheless many of the people interested in the expedition believed firmly in the richness of this reported gold discovery, the Queen being among the number. Accordingly it was decided to follow up the last expedition with a very much larger one, and for this purpose a fleet of fifteen ships was got in readiness. These took along not only the necessary crews to sail the ships and collect the ore, but a hundred men to form a settlement and remain at Frobisher's Bay for a year. The fleet sailed in May, 1578, and arrived at its destination about the 1st of August, though one ship sank on the way. Capt. Best of the "Ann Francis," one of the ships of the fleet, discovered "a great black island with plenty of black ore on it." The work of loading some of the ships went on through the month of August. While the "ore" was being mined and loaded, the masons and carpenters who had been brought from England to erect a fort, built a small stone house and within the house, they built an oven and placed some baked bread in it in order to show the Eskimos, who occupied the country, how to build a house and what to do in it when it was built. On the last day of August, all set sail for England, where they arrived about the 1st of October, but what became of the so-called ore is not known. Certainly the Company of Cathay, under whose name the enterprise was undertaken, met with financial disaster.

The scene of Frobisher's mining operations was unvisited for nearly three centuries, and it remained for Capt. C. F. Hall in 1861 and 62, while exploring in Frobisher's Bay, to rediscover all that was left of Frobisher's stone house and the pits dug by his men in their mining operations.

It might be an interesting trip for some of the many owners of yachts on the eastern coast of America to go to Frobisher's Bay and revisit the site of this mining stampede of three centuries and a half ago. It is possible that the black rocks referred to by these old sailors may have belonged to the Keewatin or Pre-Cambrian series which is yielding such large quantities of gold in Porcupine at the present time.

The next record that we have which would indicate any interest in the mineral wealth of Canada was in 1609 when Master Simon, a French mining engineer who accompanied a military expedition under De Mont, discovered native copper at Cape Doré on the east coast of Nova Scotia.

In 1672 Denys mentions coal seams near Sydney, Cape Breton, this being the first record of coal on the Continent of America. From that time onwards coal has been mined more or less continuously from these seams. In 1711, a British naval expedition sent to attack Quebec obtained coal from these seams where they outcrop in the cliffs, and later in 1720, systematic coal mining was begun by the French to supply the men building the fortress at Louisburg, and those living in the colony at Halifax, the amount usually raised for this purpose being from two to three thousand tons a year. The coal mining industry in Nova Scotia has gone on apace since then, the annual production at the beginning of this century being 3,300,000 tons, and for 1920 it was 6,429,200 tons.

Going farther west into the Province of Quebec, the early settlers recognized the existence

of bog iron ore about the middle of the 17th century.

In 1686, Chevalier De Troyes, accompanied by D'Iberville and his two brothers, the heroes of many battles with the British, started in March from Montreal through snow-covered woods and over ice-bound rivers, with a party of one hundred armed men to attack, and if possible to destroy, the fur trading posts belonging to the Hudson's Bay Company on the shore of Hudson Bay. They traveled westward up the Ottawa River and then northward across Lake Timiskaming. While on this lake, they visited a lead mine, on its east shore, just opposite and only twelve miles away from the rich silver mines at Cobalt. Dr. Miller, of the Ontario Bureau of Mines, in one of his papers on the Cobalt District, has asked the question, "What would have happened if these Frenchmen had discovered the rich native silver ores of Cobalt, which would have competed in richness with the greatest of the silver ores of Mexico or Peru?" The question was of course unanswered.

In the beginning of the 18th Century the few white men who were in charge of the fur trading establishments of the Hudson's Bay Company, on the shore of Hudson Bay, became excited over stories brought in by Indians of great quantities of native copper which could be picked off the ground on the banks of a river away to the north, and in 1719 Captains Knight and Barlow sailed in two ships, well provided with provisions, and also with strong iron-bound boxes in which to bring back precious metals, for the north west point of Hudson Bay. They were wrecked on Marble Island and all were lost.

Three years later Captain Scroggs took another expedition up the west shore of Hudson's Bay, and Richard Norton, who was in charge of the trading post at Churchill, continued the search by land for many years.

In 1769, fifty years after Knight's ill-fated expedition, Samuel Hearne was sent inland from Churchill on foot with a band of Indians to find the great deposit of copper on the bank of the distant river. He reached the Coppermine River near its discharge into the Arctic Ocean, and verified the existence of native copper in its vicinity, but at the same time he showed that the quantity obtainable was too small to be of commercial importance.

In 1737 iron furnaces were built at St. Maurice in the Province of Quebec to smelt the bog iron ore of the vicinity. They supplied the people of Quebec with their iron for many years, and in fact have been in blast almost down to the present time.

In the Province of Ontario, the first iron furnace was built in 1810, in the County of Leeds, and the next one in 1813 at Normandale in Norfolk County near the shore of Lake Erie. This furnace remained in blast down to 1847, using bog iron ore and charcoal and producing about three tons of iron a day. The iron was used in the foundries throughout that portion of Canada for the manufacture of stoves and all ordinary iron articles.

Gold was first discovered in the gravels of the Chaudiere River and its tributaries in the Province of Quebec about 1823 or 1824, and from that time onwards some gold was recovered every year, the most active operations having been undertaken between 1860 and 1875. Altogether about $3,000,000 worth of gold has been extracted to date by mining operation from these gravels.

In 1859 or 1860 some of the pilgrims crossing the plains from the Red River Country, either from what is now the Province of Manitoba, or from the State of Minnesota, discovered gold in the sands of the Saskatchewan River, and from then until now, the sands of that river have reguarly yielded a little gold to the placer miners. In some years the yield was as much as $50,000 and in other years very much less. Altogether the river is believed to have yielded more than $600,000 worth of gold.

In British Columbia gold was discovered in 1852 in gravel at Gold Harbor on the west coast of Queen Charlotte Island, though very little mining was done. In 1857, it was discovered on the Fraser River, and in the following year a great stampede set in from California, and the country to the south, to these new diggings. Prospectors pushed up Fraser River from bar to bar, and then back through the country until, in the winter of 1860-61, they crossed over to Williams Creek and discovered the rich placers of Cariboo.

About this time the precious metal was dis-

covered in quartz veins in Nova Scotia. These veins which occur in folded Pre-Cambrian rocks have been producing gold from that time up to the present, the total yield to date being about $18,000,000.

Six years later gold was discovered in Hastings County in the Province of Ontario. The men who made the discovery knew so little about the metal that they would not believe that it was gold until they had the word of a member of the Geological Survey of Canada.

In 1868 silver was discovered by the Montreal Mining Co. at Silver Islet, on a little rocky island, less than an acre in extent, near the north shore of Lake Superior. During the next few years this mine yielded more than $3,000,000. In the vicinity of Silver Islet on the shore of the lake, silver had already been known to exist, and some small mines in that vicinity have yielded a little ore, but none of them have been sufficiently productive to add materially to the wealth of the country. After the ore at Silver Islet was exhausted, silver mining remained quiescent in Eastern Canada until the rich deposits at Cobalt were discovered in 1903.

Copper had been known to exist on the shores of Lake Superior for a century or more, but the valuable ore bodies all seem to be collected on the American side of the lake rather than in Canada. In 1847, copper ore was found at Bruce Mines on the north shore of Lake Huron, and mining was carried on there for many years with varying success.

In the decade following 1858, copper mining was prosecuted energetically and often successfully in the eastern townships of the Province of Quebec, and at one of the mines a shaft was sunk to a depth of 3,000 feet.

In 1847, the occurrence of asbestos was made known by the geologists of the Geological Survey of Canada in the southern portion of Quebec and thirty years later active mining and milling of the ore began. This industry has now developed into the largest mining industry in Quebec and provides most of the asbestos used in the world.

Such was the condition of mining in Canada in the year 1885, when the Canadian Pacific Railway was opened throughout its length from the Atlantic to the Pacific. At that time the country had a population of five million three hundred thousand people, almost entirely engaged in agricultural pursuits or in developing the immediate products of agriculture. The early settlers, both French and British, were agriculturists and had settled on the rich farming land near navigable waters, whether of the Atlantic Ocean or of the Great Lakes, for the waterways formed the main lines of transportation through the country. There were vast areas of similar rich land in the wilderness back from the water, but it could not be easily reached and little was known about it. Highways and railways were afterwards built through or near the parts of the country that had thus been settled, but the people did not begin to move into the great interior regions of Canada until about 1885, when the northern parts of the Province of Ontario, and the Provinces of Manitoba, Saskatchewan, Alberta and British Columbia were rendered accessible by the building of the C. P. R. from Montreal to Vancouver. Up to that time in spite of the many discoveries of minerals and ores of various kinds which had been made at widely scattered localities throughout the Dominion, the actual production was still very small. In 1886, the first year in which an accurate statistical report on mineral production was compiled and issued, the total output of useful minerals of all kinds, metallic and non-metallic, had a value of only $10,220,000 or $2.23 to the head of population.

A new mining era had however begun to dawn for us. The building of the C. P. R. provided means of access to a previously inaccessible country. New districts were opened up. In a rock cutting on the right-of-way of this new railway itself was exposed for the first time one of the deposits of nickel ore near Sudbury, Ontario, where the greatest nickel mines of the world are now situated.

About that time systematic geological exploration of the Rocky Mountains was begun by Dr. G. M. Dawson, one of the geologists on the Geological Survey of Canada, and with him I had the pleasure of being associated as assistant. We explored from the International Boundary northward to the Bow river, and during the summer of 1883 we determined the existence of the great coal seams in the Crow's

Nest Pass. I remember very well, a hot day on the 12th of July, when camped on the banks of Mitchell creek, on land which I believe is now owned by the Crow's Nest Pass Coal Company, we divided our energies, he going up stream and I down, and my gratification at finding the outcrop of a beautiful seam of coal three feet in thickness.

Farther west in British Columbia the great silver-lead mines of East and West Kootenay and Slocan districts were discovered and active development was begun on many of them.

As a consequence of this increased interest in mining, the mineral production rose in four years to $16,763,000 or $3.50 to each head of population.

During the next five years discoveries and development were continued with unabated enthusiasm, and production increased steadily, so that by 1895 the value of our mineral products had reached $20,500,000, or $4.05 per head, having doubled in less than a decade.

The following year the rich gold placers of the Klondike were discovered, and by 1900 the output of all our mines had increased to a value of $64,400,000 or $12 per head of population. In five years the value of the mineral production had more than trebled. Half of this increase, or a third of the total production, was derived from the rich placer mines of the Klondike, where the value of the output for 1900 was $22,275,000, but the other half of the increase was due to the general interest which the people were taking in mines and to a consequent general increase in the mineral output of the whole country. For instance the output of the mines of Nova Scotia increased $4,500,000, due chiefly to the increase in output of coal, and of British Columbia $10,700,000 made up of gold, silver, copper, lead and coal.

After 1900 the production of gold from the placers of the Klondike quickly declined, and by 1905 it had dropped from $22,275,000 to $7,875,000, but notwithstanding the heavy decrease in the production of that very interesting old camp just south of the Arctic Circle, where I myself spent seven years of my life, mining had been so successfully prosecuted throughout the Dominion that the general mineral production, instead of declining, had increased to a value of $69,000,000. This increase was divided among the various provinces as follows:

Nova Scotia, $2,200,000, chiefly coal; Quebec, $1,100,000; Ontario, $7,600,000; Manitoba, Saskatchewan, and Alberta, $3,500,000; and British Columbia, $5,700,000.

Towards the close of this half decade a new silver field was found among the pine forests of Northern Ontario by some of the men who were working on the construction of the new T. & N. O. Ry. The influence of the find was just beginning to be felt and in 1905, it accounted for about $1,400,000 of Ontario's increase. The center of this silver district is now the town of Cobalt, and up to the end of December, 1921, it had produced 323,324,000 ounces of silver, valued at $198,170,000, and its mining companies had paid $92,283,820 in dividends to their stockholders. Considering the great richness of its veins, the ore in a number of places running as high as 10,000 ozs. to the ton, and its small area, the district is one of the richest of the great silver-bearing areas of the world.

In 1910, our mineral production had increased from a value of $69,000,000 in 1905 to $106,800,000. $14,000,000 of this increase was due to the output of silver from Cobalt, while $23,000,000 was due to the general increase in mining throughout the whole of Canada. In the provinces other than Ontario, the increases were as follows: Nova Scotia, $2,700,000; Quebec, $3,800,000; Alberta, chiefly coal, $7,000,000; British Columbia, $2,100,000. At the end of this period the Porcupine gold district in Northern Ontario had been discovered, but production had scarcely begun.

In 1915 our mineral production had increased to a value of $137,000,000, with a per capita value of $17.30, the greatest increase being in the Province of Ontario, which had raised its output from $43,000,000 to $61,000,000, the items chiefly responsible for this increase being gold and nickel. Nova Scotia, Quebec and British Columbia also showed substantial increases in spite of the fact that some of the metals, etc., had had a substantial drop in value during the first years of the Great War. The value of the total metallic production in this year was $75,800,000, the principal items of which were nickel, gold, copper and silver in

the order here given, while the non-metallics had a value of $61,200,000, of which coal accounted for two thirds.

In the five year period ending in 1920, the value of our mineral production almost doubled, being in this latter year about $228,000,000, but in this instance the increase was largely in the non-metallic products, coal alone having increased in the value of output from $32,000,000 to $80,000,000. In Nova Scotia the increase was from $18,000,000 to $34,000,000 due to coal, in Quebec from $11,600,000 to $28,800,000, chiefly due to asbestos, in Ontario from $61,000,000 to $81,800,000, Alberta $9,900,000 to $33,600,000 due to coal, British Columbia, $28,700,000 to $39,400,000, its chief products being coal, copper, silver, zinc, lead and gold in the order named. Taking the whole Dominion the chief mineral products were now in order of value, coal, nickel, gold, asbestos, copper and silver.

A feature of this half decade was the great development of coal mining in Alberta, which in 1920 led all the other provinces of the Dominion.

However, the most spectacular characteristic of the decade from 1910 to 1920 was the development of the great gold mines of Porcupine and Kirkland Lake in Northern Ontario. The first gold production was in 1910, amounting to 3,089 ozs. of a value of $62,849. In 1915 it had risen to 406,577 ozs. with a value of $8,404,693. For the next three years both development and production were greatly retarded on account of the scarcity of labor, for most of the friendly miners had joined the army and were fighting for the Allies, while the mechanics that were not in the army were in munition factories. By 1920, however, labor had become more plentiful and more efficient, and production was again on the increase. In that year Porcupine and Kirkland Lake produced gold to the value of $11,686,043. In 1921 this had increased to $14,624,085, and during the year just past it will doubtless reach $21,000,000, which will place it far in advance of California, or any of the other States of the Union. For the whole of Canada the gold production for the past year will probably reach a total of $27,000,000, which will place it easily third among the gold producing countries of the world, being only exceeded by Africa and the United States.

The development of the mineral resources of the country has depended on transportation. We have seen that it had scarcely begun until the C. P. R. was built across the continent. This gigantic railway enterprise cost $680,000,000, and now our mineral production alone is rapidly reimbursing us for the great expenditure, and of course the increase in the agricultural production of the country is many times that of its mineral production.

Thus you see that although there have been spectacular discoveries of great mineral wealth in Canada at various times, and in various places, such as in Cariboo, Klondike and Cobalt, and although these fields have all declined in production, nevertheless other discoveries, perhaps not so spectacular, were made, and new mining fields were opened so that every fifth year there has been an increase of production over the previous fifth year, and that in 34 years the production has increased more rapidly than in any other country in the world, except possibly South Africa. Canadians are naturally proud of this record, even though the credit may rest much more largely with the country than with themselves.

I have presented these figures as evidence of Canada's steady and uninterrupted growth in mineral production, but necertheless it must be remembered that her population is yet very small, less than three to the square mile, and almost all of these are distributed near its southern border. Most of the knowledge of the mineral and other resources of the country has been acquired by the people who live in this southern border belt, and the greater part of such knowledge refers to the country immediately contiguous to, or at least at no great distance from, this belt.

Thus though Canada has developed into an important mining country, its mines are all situated in, or not far beyond the confines of, this southern border belt, and the vast country beyond is yielding practically nothing. Among the producing mines are the great nickel-copper mines of Sudbury, the chief source of the nickel supply of the world; the silver mines of Cobalt, perhaps the richest silver-bearing area of the world; the gold mines of Porcupine,

which comprise three of the greatest gold mines of the world, together with important mica, feldspar, and talc mines, all in the Province of Ontario; the asbestos mines of Quebec, the source of most of the asbestos of the world; the coal mines of Nova Scotia and Alberta, and the coal, copper, lead and gold mines of British Columbia. There are doubtless many mines yet to be discovered in the southern border belt, in the vicinity of those already known and in active operation, but farther north is a vast area which is still unoccupied and the mineral resources of which are yet undiscovered. The means of transportation into it are slow and imperfect, and no dependable local supplies of food are available, so that even when men penetrate into it, as they can do in canoes, they are unable to live and work there until they can obtain a regular supply of provisions from the settled country to the south. But, as you know, transportation facilities are being improved all the time. With these improvements the frontiersmen who are accustomed to live on the borders of civilization, and to start the development of a country, continue to push farther into the wilderness. They make the first discoveries where the exposures of minerals are most conspicuous, but after having made these they push farther into the wilderness and leave development to those who come forward from the larger centers of population. The three processes of discovery, development and production keep going on at the same time in different parts of the country, and as long as we have new country to explore we may be reasonably certain that new discoveries will be made and that production will increase.

The mere fact that a country has been travelled over for years by fur traders and foresters, and that mineral wealth has not yet been discovered in it is little or no indication that such wealth is not present in its rocks. Cobalt was in the middle of one of the finest white pine areas of Northern Canada, and the lumbermen had been working in it for a long time before the contractors and laborers on the T. & N. O. Ry. discovered silver in it; and the Hollinger Mine, one of the great gold mines in the Porcupine district in Northern Ontario, was right on a portage which had been used by fur traders for a century or more, and when the gold-bearing quartz veins which are now yielding gold so abundantly were discovered by the prospectors, they had already been polished by the moccasins of the traders and packers as they carried their furs down to Moose Factory on Hudson Bay, thence to be shipped to London.

At the present time our country offers a field for extensive and intensive research second to none in the world. One of the main objects of that research should be the finding of bodies of ore which could be economically developed and utilized for the benefit of mankind. There is no finer laboratory anywhere than the one in which this research must be conducted, for it was constructed by the Great Architect of the Universe himself, it is almost limitless in size, in variety of problems to be solved, and in the facilities for solving them.

Up to the present time most of the known mineral deposits of the country have been accidentally discovered by hunters, casual wanderers through the wilderness, or prospectors who have had very little training except in the school of hard knocks, although it must not be forgotten that our Scientific Departments, such as the Geological Survey of Canada, and the Geological and Mining Bureaus of the various provinces, have often pointed the way to the areas where rocks and structural conditions are the most favorable for the occurrence of ore, and where, consequently, exploration might be undertaken with the greatest likelihood of success. I hesitate even to hazard a guess as to how far our mining industry would be behind its present stage of development, were it not for the assistance given it by these departments.

But if most of the prospectors and discoverers have not been trained in colleges and universities, most of the men who have taken charge of the development of the mines after they were discovered have been college men, and the success achieved by them has doubtless been in no small measure due to their college training. The need of scientific training for mining engineers, and for all those in any way connected with the production of our mineral wealth, is increasing every day, for their work is becoming vastly more complex and difficult.

Some college trained engineers who desire or need a life in the great outdoors will use their training and knowledge in the discovery of ore bodies, where untrained men would not be likely to find them, or would pass them by. Other trained engineers will explore these ore bodies and if found to be sufficiently rich or large, will pass them on again to others, who will develop them into producing and paying mines.

Your universities as well as ours can assist in the development of Canada by giving a thorough training in mining and geology, with all the collaterals that these sciences imply, to all three classes of engineers mentioned above, and also to directors or prospective directors of mining companies so that they also may understand and appreciate the work done by their several engineers. With such assistance the Canadian Mining industry would increase and develop at an even more rapid rate than it has done in the past.

J. B. TYRRELL

THE SCIENTIFIC RESOURCES OF FRANCE

To those who harbor an impulse which keeps them, throughout life, arduously laboring in scientific fields, the great cultural institutions of France appeal with peculiar power. Some of my French friends remark, "Yes, the Frenchman invents, creates and embellishes and then ceases to interest himself in the creatures of his mind." A surgeon whose name is internationally honored said, when the purpose of this paper was explained and his aid sought in the collection of material, "C'est très important! En France, nous créons des grandes organisations, et après, nous nous en moquons trop!" In a sense it may be true that the intellectual wines of Europe need no bush, yet descriptions of the educational resources of the Old World never fail to be eagerly scanned by the American scientific public and what may be termed our general student body. Novel light on the ancient beaten paths which all students must tread, pointing again the rough, unroyal highway in which the world's best workers have bruised their hearts and cudgelled their brains, seems ever welcome. It reminds present pilgrims of the beautiful democracy of ideas, or aristocracy of ideas, if you will, which has placed marvelous forces within reach of every human mind which would seek to employ and direct them. And, besides an undertaking for my own countrymen, the present paper constitutes a labor of love and humble tribute devoted to the genius of France. Probably there have never been as many American students in attendance at French institutions as now. There is every indication that their number will be continually swelled. The old wells of knowledge still flow and the strata of fact ever accumulate in the world's huge centers. The flood of inquiring spirits surges about the doors of hoary institutions and threatens to submerge and block their portals, yet is somehow sluiced away, leaving ample room for perpetually rising tides.

The undergraduate institutions, such as the Sorbonne, University of Paris, and provincial universities like those of Lille, Lyon, Strasbourg, Bordeaux, Montpellier, Grenoble and many others possess libraries, laboratories and museums which may be utilized by post-graduate students. In fact, the special student may find that his particular needs will require a visit to one or more of the schools outside Paris. For French students living far from Paris, the local university and its attributes are highly important. The foreign student naturally first interests himself in Paris.

At Paris, the Institut de France, Académie de Médécine, Collège de France, Institut National Agronomique, Académie d'Agriculture, Institut Pasteur and, especially, the libraries, are supremely interesting. In addition, the Observatories, Radium Institute, various museums, the Polytechnic School, Institute of the Arts et Métiers and other special colleges, laboratories and manifold sources of information are available to the special worker.

All these organizations are separate and independent. Sometimes a loosely common tie is constituted by direction by the same ministry, such as that of the Public Instruction, Agriculture, etc. However, the faculties, officers and members are not officially inter-related. The institutions have originated differently and developed, each by itself, through centuries of changing and often troublous history. In a