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Chapter 1 : International Association on the Genesis of Ore Deposits

*The genesis of ore-deposits (c.3) [FrantiÅ¡ek PoÅ¡epnÃ½] on calendrierdelascience.com *FREE* shipping on qualifying offers. This book was digitized and reprinted from the collections of the University of California Libraries.*

Processes of Ore Formation Current theories of the genesis of ore deposit can be divided into internal endogene and external exogene or surface processes. It must be understood that more than one mechanism may be responsible for the formation of an ore body. Example - stockwork porphyry copper deposit at depth epigenetic with a syngenetic massive sulfide deposit at the surface. The Table at the end of the document summarizes the principal theories of ore genesis, Depending upon whether an ore deposit formed at the time of and together with the enclosing rock, or was introduced into it by subsequent processes, they are classed as: Syngenetic - A deposit formed at the same time as the rocks in which it occurs. Banded Iron Formation Epigenetic - A deposit introduced into the host rocks at some time after they were deposited. Mississippi Valley-type Deposits Magmatic Deposits: Those deposits, not including pegmatites that have formed by direct crystallization from a magma. Includes 1 gravitative settling; 2 flowage differentiation; 3 filter pressing and 4 dilation. Number 1 is the most important and results from the settling of early formed crystals to the bottom of the magma chamber. Rocks formed in this manner are termed cumulates and are often characterized by rhythmic layering. In ore deposits we deal with silicate and sulfide magmas. As a magma cools, sulfides coalesce as droplets and due to higher density settle out. Most common sulfides are iron sulfides, but nickel, copper and platinum also occur. The settling out of the heavier sulfides results in the peculiar net-textured ores often found in many of these deposits. Pegmatites are very coarse grained igneous rocks. Commonly form dike-like masses a few meters to occasionally km in length. Economic ore deposits are associated with granitic pegmatites since felsic magmas carry more water. Residual elements such as Li, Be Nb, Ta, Sn and U that are not readily accommodated in crystallizing silicate phases end up in the volatile fraction. When this fraction is injected into the country rock a pegmatite is formed. Pegmatites are divided into simple and complex. Simple pegmatites consist of plagioclase, quartz and mica and are not zoned. Complex have a more varied mineralogy and are strongly zoned. Crystals in pegmatites can be large, exceeding several meters. Three hypotheses to explain their formation: Hot aqueous solutions are responsible for the formation of many ore deposits. Analysis of the fluid in inclusions has shown that water is the most important phase and salinities are often much greater than those of seawater. The chemistry of ore fluids and the mechanism of deposition of ore minerals remains a subject of hot debate. Arguments boil down to a source and nature of the solutions b means of transport of the metals and c mechanism of deposition. Pyrometasomatic deposits skarns developed at the contact of plutons and host rock. Generally, host rock is a carbonate and new minerals formed are the calc-silicates diopside, andradite and wollastonite. Introduction of Si, Al, Fe, Mg 3. Sodic metasomatism of K-spar is thought to have been important in the concentration of gold at Kalgoorlie. Conversion of feldspar from K-spar 1. Skip over Mechanical-chemical sedimentary processes since they are covered in the other course. Some ore deposits often show spatial relationships to volcanic rocks. They are conformable with the host and frequently banded suggesting sedimentary processes. Principal constituent is pyrite with lesser chalcopyrite, aphalerite, galena, barite and Ag-Au. They show a progression of types with three distinct end members: Cyprus type - Associated with mafic volcanics and ophiolite sequences. Found in spreading centers and back arc basins. Consist predominantly of pyrite with lesser chalcopyrite. Typified by the Cyprus pyrite-cu ores. Besshi type - Associated with basaltic to dacitic volcanism. Thought to form during the initial stages of island arc formation. Many Besshi type deposits occur in Precambrian rocks and these may have been generated in entirely different tectonic settings. Pyrite dominant, but chalcopyrite and sphalerite very common. Typified by many of the volcanogenic deposits of Canada. Kuroko type - Associated with dacitic to rhyolitic volcanics. Form during the waning stages of island arc volcanism. Pyrite occurs, but is not dominant Usually galena or sphalerite are predominate with lesser chalcopyrite and tetrahedrite. Also significant silver in this type. Typified by the Kuroko deposits. Although it is agreed ores are associated with volcanism the source of the ore bearing solutions continues to be debated. Many feel ore fluids are of magmatic origin, but

others feel they are merely convecting seawater.

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15th Biennial Meeting of the Society for Geology Applied to Mineral Deposits, 27 - 30 August, "Life with Ore Deposits on Earth - LODE 19" The Society for Geology Applied to Mineral Deposits (SGA) invite you to come to The University of Glasgow for the SGA's 15th Biennial Meeting, August,

Magmatic processes[edit] Fractional crystallization: As early crystallizing minerals form from magma , they incorporate certain elements, some of which are metals. These crystals may settle onto the bottom of the intrusion , concentrating ore minerals there. Chromite and magnetite are ore minerals that form in this way. As a magma changes, parts of it may separate from the main body of magma. Two liquids that will not mix are called immiscible; oil and water are an example. In magmas, sulfides may separate and sink below the silicate-rich part of the intrusion or be injected into the rock surrounding it. These deposits are found in mafic and ultramafic rocks. Hydrothermal processes[edit] These processes are the physicochemical phenomena and reactions caused by movement of hydrothermal water within the crust, often as a consequence of magmatic intrusion or tectonic upheavals. The foundations of hydrothermal processes are the source-transport-trap mechanism. Sources of hydrothermal solutions include seawater and meteoric water circulating through fractured rock, formational brines water trapped within sediments at deposition , and metamorphic fluids created by dehydration of hydrous minerals during metamorphism. Metal sources may include a plethora of rocks. However most metals of economic importance are carried as trace elements within rock-forming minerals, and so may be liberated by hydrothermal processes. This happens because of: These metal-bearing complexes facilitate transport of metals within aqueous solutions, generally as hydroxides , but also by processes similar to chelation. The majority of metal deposits formed by hydrothermal processes include sulfide minerals , indicating sulfur is an important metal-carrying complex. Sulfide deposition within the trap zone occurs when metal-carrying sulfate, sulfide, or other complexes become chemically unstable due to one or more of the following processes; falling temperature, which renders the complex unstable or metal insoluble loss of pressure, which has the same effect reaction with chemically reactive wall rocks, usually of reduced oxidation state , such as iron-bearing rocks, mafic or ultramafic rocks , or carbonate rocks degassing of the hydrothermal fluid into a gas and water system, or boiling, which alters the metal carrying capacity of the solution and even destroys metal-carrying chemical complexes Metal can also precipitate when temperature and pressure or oxidation state favour different ionic complexes in the water, for instance the change from sulfide to sulfate, oxygen fugacity , exchange of metals between sulfide and chloride complexes, et cetera. Metamorphic processes[edit] Lateral secretion: Ore deposits formed by lateral secretion are formed by metamorphic reactions during shearing , which liberate mineral constituents such as quartz, sulfides, gold, carbonates, and oxides from deforming rocks, and focus these constituents into zones of reduced pressure or dilation such as faults. This may occur without much hydrothermal fluid flow, and this is typical of podiform chromite deposits. Metamorphic processes also control many physical processes which form the source of hydrothermal fluids, outlined above. Sedimentary or surficial processes exogenous [edit] Surficial processes are the physical and chemical phenomena which cause concentration of ore material within the regolith , generally by the action of the environment. This includes placer deposits, laterite deposits, and residual or eluvial deposits. The physical processes of ore deposit formation in the surficial realm include; erosion deposition by sedimentary processes, including winnowing , density separation e. For example, sedimentary exhalative deposits SEDEX , are a class of ore deposit formed on the sea floor sedimentary by exhalation of brines into seawater exhalative , causing chemical precipitation of ore minerals when the brine cools, mixes with sea water, and loses its metal carrying capacity. Ore deposits rarely fit neatly into the categories in which geologists wish to place them. Many may be formed by one or more of the basic genesis processes above, creating ambiguous classifications and much argument and conjecture. Often ore deposits are classified after examples of their type, for instance Broken Hill type lead-zinc-silver deposits or Carlinâ€”type gold deposits. Classification of hydrothermal ore deposits is also achieved by classifying according to the temperature of formation, which roughly also correlates with particular mineralising fluids, mineral associations and

structural styles. This scheme, proposed by Waldemar Lindgren classified hydrothermal deposits as hypothermal, mesothermal, epithermal, and telethermal. It is also possible to organise theories the other way, namely according to geological criteria of formation. Often ores of the same metal can be formed by multiple processes, and this is described here under each metal or metal complex. Iron ore Iron ores are overwhelmingly derived from ancient sediments known as banded iron formations BIFs. These sediments are composed of iron oxide minerals deposited on the sea floor. Particular environmental conditions are needed to transport enough iron in sea water to form these deposits, such as acidic and oxygen-poor atmospheres within the Proterozoic Era. Often, more recent weathering is required to convert the usual magnetite minerals into more easily processed hematite. Some iron deposits within the Pilbara of West Australia are placer deposits, formed by accumulation of hematite gravels called pisolites which form channel-iron deposits. These are preferred because they are cheap to mine. Lead zinc silver[edit] Main articles: Sedimentary exhalative deposits , Carbonate-hosted lead-zinc ore deposits , and Volcanogenic massive sulfide ore deposit Lead - zinc deposits are generally accompanied by silver , hosted within the lead sulfide mineral galena or within the zinc sulfide mineral sphalerite. Lead and zinc deposits are formed by discharge of deep sedimentary brine onto the sea floor termed sedimentary exhalative or SEDEX , or by replacement of limestone , in skarn deposits, some associated with submarine volcanoes called volcanogenic massive sulfide ore deposits or VMS , or in the aureole of subvolcanic intrusions of granite. The carbonate replacement type deposit is exemplified by the Mississippi valley type MVT ore deposits. MVT and similar styles occur by replacement and degradation of carbonate sequences by hydrocarbons , which are thought important for transporting lead. Gold[edit] High-grade bonanza gold ore, brecciated quartz-adularia rhyolite. Native gold Au occurs in this rock as colloform bands, partially replaces breccia clasts, and is also disseminated in the matrix. Gold deposits are formed via a very wide variety of geological processes. Deposits are classified as primary, alluvial or placer deposits, or residual or laterite deposits. Often a deposit will contain a mixture of all three types of ore. Plate tectonics is the underlying mechanism for generating gold deposits. The majority of primary gold deposits fall into two main categories: Lode gold deposits are generally high-grade, thin, vein and fault hosted. They are primarily made up of quartz veins also known as lodes or reefs, which contain either native gold or gold sulfides and tellurides. Lode gold deposits are usually hosted in basalt or in sediments known as turbidite , although when in faults , they may occupy intrusive igneous rocks such as granite. Lode-gold deposits are intimately associated with orogeny and other plate collision events within geologic history. Most lode gold deposits sourced from metamorphic rocks because it is thought that the majority are formed by dehydration of basalt during metamorphism. The gold is transported up faults by hydrothermal waters and deposited when the water cools too much to retain gold in solution. Intrusive related gold usually also contains copper , and is often associated with tin and tungsten , and rarely molybdenum , antimony , and uranium. Intrusive-related gold deposits rely on gold existing in the fluids associated with the magma White, , and the inevitable discharge of these hydrothermal fluids into the wall-rocks Lowenstern, Skarn deposits are another manifestation of intrusive-related deposits. Placer deposits are sourced from pre-existing gold deposits and are secondary deposits. Placer deposits are formed by alluvial processes within rivers and streams, and on beaches. Placer gold deposits form via gravity , with the density of gold causing it to sink into trap sites within the river bed, or where water velocity drops, such as bends in rivers and behind boulders. Often placer deposits are found within sedimentary rocks and can be billions of years old, for instance the Witwatersrand deposits in South Africa. Placer deposits are often worked by fossicking , and panning for gold is a popular pastime. Laterite gold deposits are formed from pre-existing gold deposits including some placer deposits during prolonged weathering of the bedrock. Gold is deposited within iron oxides in the weathered rock or regolith , and may be further enriched by reworking by erosion. Some laterite deposits are formed by wind erosion of the bedrock leaving a residuum of native gold metal at surface. A bacterium, Cupriavidus metallidurans plays a vital role in the formation of gold nuggets , by precipitating metallic gold from a solution of gold III tetrachloride , a compound highly toxic to most other microorganisms. The source of platinum and palladium deposits is ultramafic rocks which have enough sulfur to form a sulfide mineral while the magma is still liquid. This sulfide mineral usually pentlandite , pyrite , chalcopyrite , or pyrrhotite gains platinum by mixing

with the bulk of the magma because platinum is chalcophile and is concentrated in sulfides. Alternatively, platinum occurs in association with chromite either within the chromite mineral itself or within sulfides associated with it. Sulfide phases only form in ultramafic magmas when the magma reaches sulfur saturation. This is generally thought to be nearly impossible by pure fractional crystallisation, so other processes are usually required in ore genesis models to explain sulfur saturation. These include contamination of the magma with crustal material, especially sulfur-rich wall-rocks or sediments; magma mixing; volatile gain or loss.

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A. The Vadose Underground Circulation, Filling of Open Spaces Formed by Vadose Circulation, B. The Deep Underground Circulation, Ascending Waters Encountered in Mines, Related Phenomena near the Surface, Mineral Springs at the Surface, Chemical Constitution of Mineral Waters, Minute Metallic.

Formation, characteristics and contrasting implications for exploration Jeffrey Hedenquist T1: Epithermal gold deposit Convenor: Ore deposits in extensional tectonic settings T3: Ore deposits related to granites: Yanbo Cheng Australia T4: Metallogeny of the Andes Convenor: Metallogeny of cratonic areas T6: Global tectonics and Metallogeny: Non conventional ore sources: Exploration and extraction T8: Geochemistry of ore forming fluids T9: Precision Geochronology and isotope geology of ore-forming processes: Predictive modelling applied to mineral resources T New discoveries and new research on skarn deposits Conveners: South America has some of the largest skarn deposits in the world, including Antamina and Las Bambas. This session will focus on recent advances in understanding the geology, geochemistry, and mineralogy of skarn deposits across the globe. New developments in magmatic sulfide and oxide deposits in South America and worldwide Conveners: Their formation results from processes that involve major fluxes of metals from the mantle to the crust, through magmatism, and the diversity of the deposits is determined by a range of crustal processes, including chemical fractionation and contamination and increasingly recognised physical processes such as sulfide injection, slumping, brecciation and entrainment in magmas on a range of scales. We welcome contributions that cover a broad range of approaches from the field, mineralogical and geochemical studies, through to large scale mineral systems approaches. Within this session, there will be a focus on recent developments in South America, alongside presentations covering deposits worldwide. Andrew Kerr, Memorial University, St. Magmatic-hydrothermal systems and the formation of ore deposits Conveners:

Chapter 4 : Ore Geology Reviews - Journal - Elsevier

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Page - A conspicuous illustration of ore-deposits of this class which may be mentioned are the metallic copper deposits of the Lake Superior region. The copper was in all probability reduced and precipitated directly as metallic copper from upward moving cupriferous solutions.

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Chapter 7 : The Genesis of Ore-Deposits

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Chapter 8 : Ore - Wikipedia

Various theories of ore genesis explain how the various types of mineral deposits form within the Earth's crust. Ore-genesis theories vary depending on the mineral or commodity examined. Ore-genesis theories generally involve

three components: source, transport or conduit, and trap.

Chapter 9 : Processes of Ore Formation

Ridge, J. D. / PROCEEDINGS OF THE FIFTH QUADRENNIAL IAGOD SYMPOSIUM, The International Association on the Genesis of Ore Deposits, Volume 1, Papers presented at the Symposium on topics related to general problems on the genesis of the ore deposits and on studies of the ore geology of specific districts or deposits (exclusive on Western North.