Deposit Classification Scheme for the Critical Minerals Mapping Initiative Global Geochemical Database
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Conversion Factors

U.S. customary units to International System of Units

| Multiply                  | By      | To obtain             |
|--------------------------|---------|-----------------------|
| Mass                     |         |                       |
| ton, short (2,000 lb)    | 0.9072  | metric ton (t)        |
| ton, long (2,240 lb)     | 1.016   | metric ton (t)        |

Abbreviations

CMMI  Critical Minerals Mapping Initiative
E.O.  Executive Order
USGS  U.S. Geological Survey
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Abstract

A challenge for the global economy is to meet the growing demand for commodities used in today’s advanced technologies. Critical minerals are commodities (for example, elements, compounds, minerals) deemed vital to the economic and national security of individual countries that are vulnerable to supply disruption. The national geological agencies of Australia, Canada, and the United States recently joined forces to advance understanding and foster development of critical mineral resources in their respective countries through the Critical Minerals Mapping Initiative (CMMI). An initial goal of the CMMI is to fill the knowledge gap on the abundance of critical minerals in ores. To do this, the CMMI compiled modern multielement geochemical data generated by each agency on ore samples collected from historical and active mines and prospects from around the world. To identify relationships between critical minerals, deposit types, deposit environments, and mineral systems, a unified deposit classification scheme was needed. This report describes the scheme developed by the CMMI to classify the initial release of geochemical data. In 2021, the resulting database—along with basic query, statistical analysis, and display tools—will be served to the public through a web-based portal managed by Geoscience Australia. The database will enable users to trace critical minerals through mineral systems and identify individual deposits or deposit types that are potential sources of critical minerals.

Background

The Critical Minerals Mapping Initiative (CMMI) involving Australia, Canada, and the United States was solidified by participants from all three countries in a workshop held in Ottawa, Canada, in December 2019 (Kelley, 2020). Before and after establishment of the CMMI, Australia, Canada, and the United States took steps to identify, and ensure the supply of, critical minerals as described below. As a result, the CMMI is a high priority for the premier geoscience agencies of the three countries: Geoscience Australia, the Geological Survey of Canada, and the U.S. Geological Survey (USGS).

Australia

In 2019, the Australian Department of Industry, Innovation and Science, jointly with the Australian Trade and Investment Commission, issued Australia’s Critical Minerals Strategy (Commonwealth of Australia, 2019b). This document, together with the Australian Critical Minerals Prospectus (Commonwealth of Australia, 2019a), formed the basis of Australia’s response to growing global requirements for a reliable supply of critical minerals. These key documents build on previous work by Geoscience Australia to catalogue Australia’s critical mineral resources and potential (for example, Skirrow and others, 2013). In response to the global need for critical commodities, the Australian Government launched several initiatives, including the establishment of the Critical Minerals Facilitation Office (Commonwealth of Australia, 2020b) and the extension and expansion of Geoscience Australia’s Exploring for the Future program (Commonwealth of Australia, 2020c). Australia is currently a supplier of many critical (and other) minerals and seeks to strengthen and extend its capability as a reliable supplier to global partners. As part of Australia’s Critical Minerals Strategy, Australia has identified 24 critical minerals for which it has significant potential to be a major supplier (table 1). The 2020 edition of the Australian Critical Minerals Prospectus (Commonwealth of Australia, 2020a) showcases more than 200 investment opportunities for a wide range of these 24 critical minerals.
Table 1. Critical minerals of Australia, Canada, and the United States.

[This list of identified critical minerals has been compiled from Commonwealth of Australia (2019b), Government of Canada (2021), and Fortier and others (2018). —, not applicable; X, identified as a critical mineral]

| Critical mineral                  | Australia | Canada | United States |
|----------------------------------|-----------|--------|---------------|
| Aluminum (Al)                    | —         | X      | X             |
| Antimony (Sb)                    | X         | X      | X             |
| Arsenic (As)                     | —         | —      | X             |
| Barite (BaSO₄)                   | —         | —      | X             |
| Beryllium (Be)                   | X         | —      | X             |
| Bismuth (Bi)                     | X         | X      | X             |
| Cesium (Cs)                      | —         | X      | X             |
| Chromium (Cr)                    | X         | X      | X             |
| Cobalt (Co)                      | X         | X      | X             |
| Copper (Cu)                      | —         | X      | —             |
| Fluorspar (CaF₂)                 | —         | X      | X             |
| Gallium (Ga)                     | X         | X      | X             |
| Germanium (Ge)                   | X         | X      | X             |
| Graphite (C)                     | X         | X      | X             |
| Hafnium (Hf)                     | X         | —      | X             |
| Helium (He)                      | X         | X      | X             |
| Indium (In)                      | X         | X      | X             |
| Lithium (Li)                     | X         | X      | X             |
| Magnesium (Mg), Magnesite (MgCO₃) | X         | X      | X             |
| Manganese (Mn)                   | X         | X      | X             |
| Molybdenum (Mo)                  | —         | X      | —             |
| Nickel (Ni)                      | —         | X      | —             |
| Niobium (Nb)                     | X         | X      | X             |
| Platinum group elements (PGEs)   | X         | X      | X             |
| Potash (K₂CO₃, KCl, K₂SO₄, or KNO₃) | —     | X      | X             |
| Rare earth elements (REEs)       | X         | X      | X             |
| Rhenium (Re)                     | X         | —      | X             |
| Rubidium (Rb)                    | —         | —      | X             |
| Scandium (Sc)                    | X         | X      | X             |
| Strontium (Sr)                   | —         | —      | X             |
| Tantalum (Ta)                    | X         | X      | X             |
| Tellurium (Te)                   | —         | X      | X             |
| Tin (Sn)                         | —         | X      | X             |
| Titanium (Ti)                    | X         | X      | X             |
| Tungsten (W)                     | X         | X      | X             |
| Uranium (U)                      | —         | X      | X             |
| Vanadium (V)                     | X         | X      | X             |
| Zinc (Zn)                        | —         | X      | —             |
| Zirconium (Zr)                   | X         | —      | X             |
Canada

On December 18, 2019, Canada announced that it had joined the U.S.-led multilateral Energy Resource Governance Initiative. The goals of the initiative are to support secure and resilient supply chains for critical minerals by identifying options to diversify supply chains and facilitate trade and industry connections. On January 9, 2020, the Canada-U.S. Joint Action Plan on Critical Minerals Collaboration was finalized and aimed to facilitate development of secure supply chains for critical minerals (Amm and others, 2020). The Canada-U.S. Joint Action Plan was reaffirmed on June 17, 2020 (Natural Resources Canada, 2020). Later that year, focus on critical minerals was reiterated and emphasized in the Canadian Minerals and Metals Plan (Mines Canada, 2020). Canada’s list of 31 critical minerals was released on March 11, 2021 (table 1; Government of Canada, 2021). These critical minerals are considered essential for the sustainable economic success of Canada and its allies and to maintain Canada’s position as a leading mining nation. A key platform for delivering minerals geoscience knowledge at the Geological Survey of Canada is its Targeted Geoscience Initiative Program, now in Phase 6. The focus of the program is on developing next-generation ore deposit models and methods to support enhanced efficiency in mineral exploration for buried mineral deposits in emerging and existing mining areas. The focus of the current phase is on critical minerals and digital geoscience, as described in the Canadian Minerals and Metals Plan (Mines Canada, 2020).

United States

In 2017, the President issued Executive Order (E.O.) 13817—A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals. The E.O. directs the USGS to develop a plan to improve the Nation’s understanding of domestic critical mineral resources. To implement E.O. 13817, the Secretary of the Interior issued Order No. 3359—Critical Mineral Independence and Security. In response, a list of 35 critical minerals (table 1) with a high risk for supply disruption were identified by the USGS National Minerals Information Center (Fortier and others, 2018). In 2018, Congress allocated funds to the USGS Mineral Resources Program for the Earth Mapping Resources Initiative. The purpose of this initiative is to generate topographic, geologic, geochemical, and geophysical maps and data that are needed to increase the inventory of domestic critical minerals (Day, 2019). Several other Mineral Resources Program projects are currently underway that are designed to advance knowledge of critical minerals, including their abundance in the Nation’s ore deposits and mine waste, their sources, the processes that concentrate them in mineral systems, and how to assess their potential in known mining districts and frontier areas. In 2020, the President determined that the United States’ undue reliance on critical mineral imports, in processed or unprocessed form, constitutes an unusual and extraordinary threat. As a result, the President declared a National emergency, and issued E.O. 13953—Addressing the Threat to the Domestic Supply Chain From Reliance on Critical Minerals From Foreign Adversaries and Supporting the Domestic Mining and Processing Industries. The 2020 E.O. directed the Department of Interior (which includes the USGS) to investigate our Nation’s undue reliance on critical minerals, submit a report that summarizes the conclusions from this investigation, and provide recommendations for executive action. On January 15, 2021, the U.S. Department of Energy announced the establishment of a Division of Minerals Sustainability to enable the ongoing transformation of the U.S. energy system and help secure a U.S. critical minerals supply chain (U.S. Department of Energy, 2021).

Problem

An initial goal of the CMMI (Kelley, 2020; Emsbo and others, 2021; Kelley and others, 2021) is to compile multielement geochemical data on ore samples collected from myriad deposit types and provide the data to the public with basic query, statistical analysis, and display tools that show the abundance and dollar value of critical minerals in ore. To effectively sort and use multielement geochemical data for this purpose, a unified deposit type classification scheme was needed. This report explains the approach used to standardize deposit type nomenclature and demonstrates the hierarchical relationships that exist between system types, deposit environments, deposit groups, and deposit types. The resulting classification scheme and its potential uses are then discussed.

Approach

To track critical minerals through mineral systems and identify ore deposits that concentrate them, a mineral systems approach based on current understanding of how ore deposits form and relate to broader geologic frameworks and the tectonic history of the Earth was used (for example, Wyborn and others, 1994; Goodfellow, 2007; Dulfer and others, 2016; Huston and others, 2016b). This approach was recently applied in the United States and Canada to aid delineation of system-based focus areas with critical mineral resource potential (Day, 2019; Hammarstrom and Dicken, 2019; Hammarstrom and others, 2020; Hofstra and Kreiner, 2020; Lawley and others, 2021). Herein, the systems approach provides a framework within which to consider the hierarchical relationships that are known, or inferred, to exist between system types, deposit environments, deposit groups, and deposit types that contain a variety of primary and secondary commodities, some of which are critical minerals. This exercise required the CMMI working group to agree on terminology for system types, deposit environments, deposit groups, and deposit types. The result
presented in this report is a compromise that was deemed useful for classification of geochemical data generated by the CMMI on ore samples from myriad mines and prospects around the world.

**System Type (Genetically Related Features)**

To capture the relationship that exists between system types and distinct deposit types that are generated by them, system-type nomenclature was needed. As of spring 2021, the CMMI working group is still working on system-type names. To facilitate their eventual placement in the classification scheme, a descriptive proxy was developed, called genetically related features, that lists key attributes of each system type. For example, the genetically related features entry for calc-alkaline volcano-plutonic center, magmatic fluid, alkali and hydrolytic metasomatism, and myriad deposit types.” The attributes listed in genetically related features are self-explanatory to the intended audience of economic geologists.

**Deposit Environment**

The CMMI working group agreed on deposit-environment terms because they follow current usage. “Deposit environment” is more or less synonymous with ore-forming environment and is used to classify deposit types that form under distinct physiochemical conditions, from different fluids, or by different processes in the crust. Deposit environments differ from system types because they are more generic. For example, an intrusion-related rare metal system may generate magmatic lithium-cesium-tantalum-bearing pegmatite and magmatic-hydrothermal tin-bearing greisen and vein deposits. Although most of the deposit environment terms are self-explanatory, they are defined below to avoid confusion:

- In erosional environments, gravity-driven turbulent flow of surface water or tidal- and wind-driven wave action concentrate heavy, insoluble, or hard minerals by winnowing away light, soluble, or soft minerals.
- In supergene environments, elements released by chemical weathering of soluble minerals are concentrated by chemical gradients associated with the downward percolation of meteoric water in the unsaturated zone.
- In infiltrational environments, elements dissolved from soluble minerals by gravity-driven flow of oxidized meteoric groundwater are concentrated by chemical gradients encountered in aquifers.
- In basin evaporative environments, elements present in closed lacustrine or silled marine basins are concentrated by evaporation in arid to hyperarid climatic zones until they precipitate from brines.
- In basin chemical environments, elements dissolved in freshwater or seawater precipitate at redox fronts in sedimentary basins.
- In basin hydrothermal environments, elements are dissolved from minerals by gravity-driven and (or) heat-driven flow of brines produced by the evaporation of seawater or dissolution of minerals; elements are concentrated by chemical gradients encountered in basin aquifers or at the seawater-sediment interface.
- In metamorphic environments, ore minerals are produced by metamorphic transformation of precursor minerals that contain valuable commodities.
- In metamorphic hydrothermal environments, elements dissolved in metamorphic (= magmatic) fluids are concentrated by physical and chemical gradients encountered along flow paths.
- In regional metasomatic environments, elements dissolved in magmatic, metamorphic, or basin brines are concentrated by chemical and thermal gradients encountered along heat-, tectonic-, and gravity-driven flow paths.
- In volcanic basin hydrothermal environments, elements dissolved from volcanic-floored basins by heat-driven convection of seawater (= magmatic fluid) are concentrated by steep chemical and thermal gradients near seafloor vents.
- In magmatic hydrothermal environments, elements dissolved in magmatic fluids, brines, and vapors, or in heated external fluids, are concentrated by the steep chemical and thermal gradients around volcano-plutonic centers.
- In magmatic environments, ore minerals crystallize directly from igneous melts, including immiscible silicate, carbonate, sulfide, or other melts.

**Deposit Group and Deposit Type**

The CMMI working group began by considering past and current nomenclature for deposit types in each of the three countries. During this process, it became apparent that the classification principles and names applied to deposit types were often inconsistent, creating communication problems that needed to be resolved. For example, how can we characterize the critical mineral endowment of different system types and individual deposit types on the basis of the compiled geochemical data if geologically similar deposit types, and ore samples collected from them, are inadvertently ascribed to different deposit and system types based purely on differences in terminology? Such characterizations would also fail if distinct deposit types are ascribed to the same type because
of inconsistent classification principles. The aim of this report is not to replace existing deposit classification schemes or resolve all the geological arguments about deposit genesis; rather, the aim is to minimize confusion caused by the use of inconsistent terminology by members of the CMMI, so that compiled geochemical data can be assigned and interpreted effectively. The classification scheme presented herein may stimulate conversations in the economic geology community about standardization of terminology to avoid confusion.

Although we strived for hierarchical uniformity, as described in the ensuing paragraphs, the deposit types adopted in the classification scheme are not all at the same level.

We found that some of the deposit type names in common use actually represent mineral systems, rather than distinct deposit types. For example, intrusion-related gold systems generate an assemblage of distinct deposit types (Hart, 2007) that are all commonly referred to as “intrusion-related gold deposits.” The same goes for the array of distinct deposit types that are commonly referred to as “iron oxide-copper-gold deposits” (Barton, 2014), though more detailed classifications exist for these and their affiliated deposit types (Porter, 2010; Williams, 2010; Corriveau and others, 2016). In such cases, we split out deposit types with distinct characteristics and assigned names.

Other deposit types were considered to be subtypes, but this level of detail was deemed too fine for the intended purposes of this classification scheme. For example, Naldrett (2004) distinguished several subtypes of magmatic nickel-copper-platinum group element deposits based on magma composition. Some of the more commonly used subtypes are listed in the “Synonyms” column in Table 2.

We also noted that some deposit types occur in more than one system type. For example, intermediate sulfidation epithermal silver-gold deposits occur in both subduction-related calc-alkaline porphyry-epithermal systems and rift-related high silica A-type porphyry-epithermal systems. We did not give such deposit types different names because their system type affiliations (that is, genetically related features) define their genetic relation to other deposit types.

We found that most of the deposit type names in common use consist of a term that describes a key attribute of the deposit type (for example, epithermal) that is preceded or followed by one or more commodities (for example, silver-gold) that are typically recovered from the ore. We refer to such terms as “deposit groups.” In several cases, the deposit group term is preceded by a modifier that describes another characteristic that enables further discrimination (for example, high sulfidation). Thus, most deposit type names consist of the deposit group term followed by the typical commodities (for example, porphyry copper), with or without a preceding modifier (for example, high sulfidation epithermal silver-gold).

To standardize deposit type nomenclature, we adopted the following convention:

- Optional modifier + deposit group + typical commodities.

However, we made a few exceptions for deposit type names in common use that do not follow this convention. For example, “Heavy mineral sands” is a deposit type in the placer deposit group that is typically mined for several commodities, such as titanium, zirconium-hafnium, rare earth elements, or abrasives.

Given that the deposit group terms used in this scheme mimic those in common use, the classification scheme reflects the hierarchical inconsistencies that currently exist among deposit types.

To make it clear what the deposit type names used in this classification scheme refer to, synonyms, examples, and references to reports that describe each deposit type are provided.

The resulting classification scheme (Table 2) consists of seven columns with the following headers: Genetically related features, Deposit environment, Deposit group, Deposit type, Synonyms, Examples, and References. Table 2 contains information on 189 deposit types.

### Uses

The classification scheme (Table 2) is designed to accompany the initial release of the global geochemical database on ore samples compiled by geologists from the CMMI, which will be augmented periodically as new data are compiled and classified. The scheme covers most of the significant deposit types mined historically, or currently, in Australia, Canada, and the United States. The intended use of Table 2 is to classify multielement geochemical data obtained on ore samples collected from historical and active mines by deposit type, deposit group, deposit environment, and eventually system type, and provide it to the public through a web portal (URL).

The resulting database of classified multielement geochemical analyses together with auxiliary information will enable the following:

- Recognition of the abundance of critical minerals in each deposit and their relation to the primary and secondary commodities that are known to be present in, or produced from, each deposit.

- Calculation of the dollar value of critical minerals present in ore in each deposit, which may foster recovery of critical minerals.

- Calculation of average critical mineral/average primary commodity ratios for each deposit, which can be multiplied by the tons of primary commodity produced, or in resources, to estimate the critical mineral endowment of processed mine waste and unmined resources.

- Recognition of the deposit types that have been geochemically well characterized, poorly characterized, or remain to be characterized.

- Recognition of the critical minerals that are typically present in each deposit type.
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- Identification of individual deposits that have been misclassified.
- Development of grade and tonnage models for critical minerals in each deposit type.
- Comparison of critical mineral abundances in deposit types that occur in more than one system type.
- Tracing of critical minerals through each system type and identification of the deposit types that concentrate them.
- Portrayal of such data on a map or in a deposit or system model.
- Identification of geochemical data that merit explanation and research, such as the geometallurgy of samples that are enriched in critical minerals or the origin of individual deposits or systems that are unusually enriched in critical minerals.
- Identification of geochemical signatures that can refine the deposit classification scheme.
Table 2. Deposit classification scheme.

| Genetically related features                                      | Deposit environment                        | Deposit group | Deposit type       | Synonym(s)                        | Example(s)                                                                 | Reference(s)                       |
|-----------------------------------------------------------------|-------------------------------------------|---------------|--------------------|-----------------------------------|-----------------------------------------------------------------------------|-----------------------------------|
| Chemical weathering, erosion of soft material, and concentration of resistate minerals in situ, preexisting mineralization | Erosional                                  | Placer        | Residual placer tin | Lag tin                           | AUS: Renison Bell; BRA: Pitinga                                              | Morland, 1990; Alves and others, 2018 |
| Chemical weathering, erosion of soft material, and concentration of resistate minerals in situ, preexisting mineralization | Erosional                                  | Placer        | Residual placer lead| Lag lead                          | MEX: Santa Eulalia; U.S.: Upper Mississippi Valley Pb, Wis. and Ill.        | Megaw, 2009                         |
| Exhumation, topographic relief, drainage network, preexisting mineralization | Erosional                                  | Placer        | Fluvial placer gold | Alluvial gold                     | AUS: Victorian goldfields, VIC, CAN: Atlin, BC, Cariboo, BC; Klondike, YT; U.S.: American River Au, Calif. | Yeend, 1986                         |
| Exhumation, topographic relief, drainage network, preexisting mineralization | Erosional                                  | Placer        | Fluvial placer PGE  | Alluvial PGE                      | U.S.: Goodnews Bay PGE-Au, Alaska                                             | Yeend and Page, 1986               |
| Exhumation, topographic relief, drainage network, preexisting mineralization | Erosional                                  | Placer        | Fluvial placer tin | Alluvial tin                      | AUS: Pilbara, WA; North Queensland, QLD; U.S.: Seward Peninsula Sn, Alaska  | Reed, 1986a                        |
| Exhumation, topographic relief, drainage network, preexisting mineralization | Erosional                                  | Placer        | Fluvial placer niobium-tantalum | Alluvial niobium-tantalum          | NGR: Jos Plateau                                                             | Pastor and Turaki, 1985            |
### Table 2. Deposit classification scheme.—Continued

| Genetically related features | Deposit environment | Deposit group | Deposit type | Synonym(s) | Example(s) | Reference(s) |
|-----------------------------|---------------------|---------------|--------------|------------|-------------|--------------|
| Exhumation, topographic relief, drainage network, preexisting mineralization | Erosional | Placer | Fluvial placer tungsten | Alluvial tungsten | CAN: Boulder Creek, BC; U.S.: Alder Creek, Alaska | Bundtzen, 1986 |
| Exhumation, topographic relief, drainage network, specific rock types | Erosional | Placer | Fluvial placer REE | Alluvial REE | AUS: Charleys Creek, NT; U.S.: Idaho, Carolina Piedmont | Sengupta and Van Gosen, 2016 |
| Exhumation, topographic relief, drainage network, kimberlite pipe | Erosional | Placer | Fluvial placer diamond | Alluvial diamond | AUS: Upper Smoke Creek (from Argyle diamond pipe), WA; Namibia: Orange River | Cox, 1986b |
| Exhumation, topographic relief, drainage network, specific rock type | Erosional | Placer | Fluvial placer gemstones | Alluvial gemstones | AUS: Anakie, QLD; Glen Innes, NSW; US: Yogo, Mont. | Clabaugh, 1952 |
| Exhumation, topographic relief, drainage network, specific rock type | Erosional | Placer | Fluvial placer garnet | Alluvial garnet | AUS: Harts Range garnet, NT; U.S.: Emerald Creek, Idaho | Evans and Moyle, 2006 |
| Exhumation, topographic relief, drainage network, delta, shoreline, barrier island, specific rock types | Erosional | Placer | Heavy mineral sands | Mineral sands | AUS: Keysbrook, WA; WIM150, VIC; Jacinth, SA; U.S.: Boise REE-Th-Ti-Nb-Ta, Idaho | Leveson, 1995; Van Gosen and others, 2014 |
| Exhumation, topographic relief, drainage network, delta, shoreline, barrier island, preexisting mineralization | Erosional | Placer | Shoreline placer gold | Beach placer gold | CAN: Graham Island, BC; Queen Charlotte Islands, BC; County Harbour, NS; U.S.: Nome Au, Alaska | Bundtzen and others, 1994 |
| Genetically related features | Deposit environment | Deposit group | Deposit type | Synonym(s) | Example(s) | Reference(s) |
|-----------------------------|---------------------|--------------|-------------|------------|------------|--------------|
| Exhumation, topographic relief, drainage network, delta, shoreline, barrier island, specific rock types | Erosional | Placer | Paleoplacer heavy mineral sands | Lithified mineral sands; indurated mineral sands | CAN: Elliot Lake-Blind River, ON; U.S.: Sanostee Mesa Ti, N. Mex. | Van Gosen and others, 2014 |
| Exhumation, topographic relief, drainage network, delta, shoreline, barrier island, specific rock types | Erosional | Placer | Paleoplacer tin | NA | AUS: Kikoira-Gibearvale, NSW | Campbell and others, 2003; Burton and Downes, 2005 |
| Exhumation, topographic relief, drainage network, delta, shoreline, barrier island, pre-existing mineralization | Erosional | Placer | Paleoplacer gold ± uranium | Quartz pebble conglomerate Au-U | CAN: Elliot Lake-Blind River, ON; U.S.: Mulvehill, BC.; U.S.: Cambrian Deadwood Fm., S. Dak.; ZAF: Witwatersrand | Cox, 1986e; Roscoe, 1995; Taylor and Anderson, 2018 |
| Stable area with low relief, tropical climate, Al-bearing rock types, unsaturated zone, water table | Supergene | Laterite | Bauxite | Lateritic bauxite | AUS: Weipa, QLD; BRA: Pocos de Caldas district; CAN: Florence, BC; U.S.: Arkansas bauxite | Gordon and others, 1958; Bárdossy and Aleva, 1990 |
| Stable area with low relief, tropical climate, Al-bearing rock types above carbonate rocks, unsaturated zone, water table | Supergene | Laterite | Karst bauxite | Carbonate bauxite | EU: Mediterranean bauxite belt; CHN: Yunnan deposits | Bárdossy, 1982; Hou and others, 2017 |
| Stable area with low relief, tropical climate, ultramafic rocks, unsaturated zone, water table | Supergene | Laterite | Laterite nickel | Nickel-coalt laterite: Lateritic nickel | AUS: Murrin Ni laterite, WA; U.S.: Puerto Rico Ni laterite | Berger and others, 2011; Marsh and others, 2013 |
| Stable area with low relief, tropical climate, carbonatites, unsaturated zone, water table | Supergene | Laterite | Carbonatite laterite REE | NA | AUS: Mt. Weld, WA | Cocker, 2014; Verplanck and others, 2016 |
| Genetically related features                                                                 | Deposit environment | Deposit group | Deposit type                  | Synonym(s) | Example(s)                                      | Reference(s)                                                                 |
|------------------------------------------------------------------------------------------------|---------------------|---------------|-------------------------------|------------|------------------------------------------------|------------------------------------------------------------------------------|
| Stable area with low relief, tropical climate, carbonatites, unsaturated zone, water table     | Supergene           | Laterite      | Laterite magnetite            | NA         | AUS: Thuddungra, NSW                             | Diemar, 1998                                                                  |
| Variable climate, unsaturated zone, Al-bearing rocks, water table                              | Supergene           | Clay          | Residual clay                 | Secondary clay |                                                |                                                                               |
| Variable climate, unsaturated zone, AI- or REE-bearing shales adjacent to coal seams, water table | Supergene           | Clay          | Underclay, overclay           | Gob        | CAN: Quinsam Mine, BC; CHN: Chongqing, Daqinshang, Lincang, Yishan; MNG: Jungar; U.S.: Coal underclay Ill.-Ky.-W. Va. | Seredin and Finkelman, 2008; Zhao and others, 2019; Yang and others, 2020 |
| Variable climate, unsaturated zone, AI- or REE-bearing granitic, peralkaline, or carbonatite rocks, water table | Supergene           | Clay          | Ion adsorption REE            | NA         | CAN: Grande-Vallée, QC; CHN: Jiangxi, Guangdong, Fujiang, Guangxi; U.S.: Piedmont ion adsorption REE | Foley and Ayuso, 2015; Sanematsu and Watanabe, 2016 |
| Variable climate, unsaturated zone, preexisting Ag-rich mineralization, water table           | Supergene           | Supergene     | Supergene silver              | NA         | AUS: Wowawinta, NSW; CAN: Murray Brook, NB; MEX: Sierra Mojada | Skirka, 2005; Sillitoe, 2009; Ahn, 2010                                      |
| Variable climate, unsaturated zone, preexisting Pb-rich mineralization, water table           | Supergene           | Supergene     | Supergene lead                | NA         | AUS: Magellan, WA                                | McQuitty and Pascoe, 1998; Pirajno and others, 2010                           |
Table 2. Deposit classification scheme.—Continued

| Genetically related features                                                                 | Deposit environment | Deposit group | Deposit type      | Synonym(s) | Example(s)                           | Reference(s) |
|---------------------------------------------------------------------------------------------|---------------------|---------------|-------------------|-----------|--------------------------------------|--------------|
| Variable climate, unsaturated zone, preexisting U-rich mineralization, water table          | Supergene           | Supergene     | Supergene uranium | NA        | AUS: Angela, NT                      | Lally and Bajwah, 2006; Bolonin and Gradovsky, 2012; Edgoose, 2013 |
| Variable climate, unsaturated zone, preexisting V-rich mineralization, water table         | Supergene           | Supergene     | Supergene vanadium | NA        | NAM: Otavi Mountainland              | Schwellnus, 1945; Verwoerd, 1957; Boni and others, 2007 |
| Variable climate, unsaturated zone, preexisting Au-rich mineralization, water table        | Supergene           | Supergene     | Supergene gold    | Regolith gold | CAN: Murray Brook, NB              | Rennick and Burton, 1992 |
| Variable climate, unsaturated zone, preexisting Zn-rich mineralization, water table        | Supergene           | Supergene     | Supergene zinc    | Non-sulfide Zn, oxidized Zn (Pb) | AUS: Magellan, WA; CAN: Redbird, Lomond, Reeves MacDonald, Caviar, HB, Oxide, Cariboo Zinc, Flipper Creek, Dolomite Flats, Main, Gunn and Que, BC; U.S.: Leadville, Colo.; Balmat, N.Y. | Boni and Mondillo 2015; Paradis and others, 2015 |
| Variable climate, unsaturated zone, preexisting Cu-rich mineralization, water table        | Supergene           | Supergene     | Supergene copper  | NA        | CAN: Afton, BC; Windy Craggy, BC; U.S.: Santa Rita (Chino) Cu, N. Mex.; Morenci, Ariz. | Titled and Marozas, 1995 |
| Variable climate, unsaturated zone, preexisting Mn-rich mineralization, water table        | Supergene           | Supergene     | Supergene manganes | NA        | AUS: Woodie Woodie, WA               | Jones, 2017 |
| Genetically related features | Deposit environment | Deposit group | Deposit type | Synonym(s) | Example(s) | Reference(s) |
|-----------------------------|--------------------|--------------|-------------|------------|------------|--------------|
| Variable climate, unsaturated zone, preexisting Fe-rich mineralization, water table | Supergene | Supergene | Supergene iron | NA | AUS: Hamersley iron province, WA; CAN: Labrador Trough, NL and QC; U.S.: Lake Superior, Minn.-Mich.-Wis. | Leith, 1931 |
| Infiltration of surface water, aquifers, preexisting Cu mineralization, redox interface | Infiltrational | Exotic | Exotic copper | Paleochannel copper | MEX: El Pilar | Münchmeyer, 1998 |
| Infiltration of surface water, fluvial paleochannels, preexisting Fe, Mn mineralization, redox interface | Infiltrational | Paleochannel | Paleochannel iron | Ferricretes, mangano-cretes | AUS: Hamersley iron province, WA; U.S.: New World, Mont. | Ramanaidou and others, 2003 |
| Infiltration of surface water, aquifers, preexisting volcanic ash-bearing sedimentary rocks, redox interface | Infiltrational | Uranium | Sandstone uranium | Roll front, and others | AUS: Angola, NT; U.S.: Colorado Plateau, Utah-Colo. | Lally and Bajwah, 2006; Edgoose, 2013; Breit, 2016; IAEA, 2020 |
| Infiltration of surface water, aquifers, preexisting volcanic ash-bearing sedimentary rocks, redox interface | Infiltrational | Uranium | Carbonate uranium | NA | U.S.: Grants, N. Mex. | IAEA, 2020 |
| Infiltration of surface water, aquifers, preexisting volcanic ash-bearing sedimentary rocks, redox interface | Infiltrational | Uranium | Coal/peat/bog uranium | NA | U.S.: Williston Basin, Mont.-N. Dak.-S. Dak. | IAEA, 2020 |
Table 2. Deposit classification scheme.—Continued

| Genetically related features | Deposit environment | Deposit group | Deposit type | Synonym(s) | Example(s) | Reference(s) |
|-----------------------------|---------------------|---------------|--------------|------------|------------|--------------|
| Infiltration of surface water, aquifers, preexisting volcanic ash-bearing sedimentary rocks, lacustrine evaporite system | Infiltrational | Uranium | Calcrete uranium | Surficial uranium, evaporite uranium | AUS: Yeelirrie, WA; U.S.: Southern High Plains, N. Mex., Okla., Tex. | Hall and others, 2019; IAEA, 2020 |
| Infiltration of CO$_2$-bearing surface water into fractured ultramafic rocks | Infiltrational | Magnesite | Nodular magnesite | Cryptocrystalline magnesite | AUS: Kunwarara, QLD; CAN: Mount Brussilof, BC; U.S.: Red Mtn., Calif. | Page, 1998b; Simandl and Hancock, 1999 |
| Silled marine basin, arid climate, pinnacle reefs, evaporites, sabkha dolomites | Basin evaporative | Evaporite | Marine evaporite gypsum | NA | CAN: Windsor, NS; Elkhorn, BC; U.S.: Oklahoma | Raup, 1991a; Warren, 2010 |
| Silled marine basin, arid climate, pinnacle reefs, evaporites, sabkha dolomites | Basin evaporative | Evaporite | Marine evaporite salt | NA | CAN: Goderich, ON; Grosse-Île, QC; U.S.: Gulf Coast, Tex. | Raup, 1991b; Warren, 2010 |
| Silled marine basin, arid climate, pinnacle reefs, evaporites, sabkha dolomites | Basin evaporative | Evaporite | Marine evaporite potash | NA | CAN: Elk Point Basin, SK; U.S.: Carlsbad, N. Mex. | Williams-Stroud, 1991; Warren, 2010 |
| Silled marine basin, arid climate, pinnacle reefs, evaporites, sabkha dolomites | Basin evaporative | Evaporite | Marine evaporite magnesite | Sedimentary magnesite | AUS: Witchelina and Mount Hutton, SA | Horn and others, 2017 |
| Closed lacustrine drainage basin, arid climate, salt flats | Basin evaporative | Evaporite | Lacustrine evaporite trona | NA | U.S.: Green River, Wyo. | Dyni, 1991; Warren, 2010 |
| Closed lacustrine drainage basin, arid climate, salt flats | Basin evaporative | Evaporite | Lacustrine evaporite salt | NA | U.S.: Bonneville, Utah | Orris, 1992; Warren, 2010 |
| Closed lacustrine drainage basin, arid climate, salt flats | Basin evaporative | Evaporite | Lacustrine evaporite potash | NA | EU: Rhine graben | Warren, 2010 |
Table 2. Deposit classification scheme.—Continued

| Genetically related features                                      | Deposit environment | Deposit group | Deposit type                  | Synonym(s)                      | Example(s)                                                                 | Reference(s)                                      |
|-----------------------------------------------------------------|---------------------|---------------|------------------------------|---------------------------------|----------------------------------------------------------------------------|---------------------------------------------------|
| Closed lacustrine drainage basin, arid climate, salt flats      | Basin evaporative   | Evaporite     | Lacustrine evaporite carnallite-bischofite | NA                              | CAN: Wynyard, SK; EU: Rhine graben                                        | Warren, 2010                                      |
| Closed lacustrine drainage basin, arid climate, salt flats      | Basin evaporative   | Evaporite     | Lacustrine evaporite borate   | NA                              | U.S.: Rio Tinto (U.S. Borax), Calif.                                        | Orris, 1995; Warren, 2010                         |
| Closed lacustrine drainage basin, arid climate, salt flats      | Basin evaporative   | Evaporite     | Lacustrine evaporite magnesite| Sedimentary magnesite           | U.S.: Needles, Calif.                                                      | Vitaliano, 1950                                   |
| Closed lacustrine drainage basin, arid climate, sea spray, salt flats | Basin evaporative   | Evaporite     | Lacustrine evaporite nitrate  | NA                              | So. Am.: Central Andes                                                     | Williams-Stroud, 1991; Warren, 2010              |
| Silled marine basin, arid climate, pinnacle reefs, evaporites,  | Basin evaporative   | Brine          | Marine brine potash (±Mg, Li, and so on) | NA                              | U.S.: Kane Creek potash, Utah; Michigan Basin potash, Mich.               | Warren, 2010                                      |
| Closed lacustrine drainage basin, arid climate, salt flats      | Basin evaporative   | Brine          | Lacustrine brine potash       | NA                              | AUS: Lake Wells, WA; U.S.: Searles Lake, Calif.                             | Orris, 2011                                      |
| Closed lacustrine drainage basin, arid climate, salt flats      | Basin evaporative   | Brine          | Lacustrine brine lithium      | NA                              | CAN: Swan Hill, AB; CHL: Atacama; U.S.: Clayton Valley, Nev.                | Bradley and others, 2013; Munk and others, 2016   |
| Closed lacustrine drainage basin, arid climate, salt flats,     | Basin evaporative   | Zeolite        | Lacustrine zeolite (± Li, B)   | NA                              | U.S.: Rhyolite Ridge, Nev.                                                  | Sheppard, 1991; Ioneer, 2020                     |
| Volcanic rocks                                                  | Basin evaporative   | Clay           | Lacustrine clay lithium       | NA                              | U.S.: McDermitt, Nev.                                                      | Asher-Bolinder, 1991; Castor and Henry, 2020     |
### Table 2. Deposit classification scheme.—Continued

| Genetically related features                                                                 | Deposit environment | Deposit group | Deposit type                        | Synonym(s)                                                                 | Example(s)                                                                 | Reference(s)                          |
|--------------------------------------------------------------------------------------------|---------------------|---------------|-------------------------------------|-----------------------------------------------------------------------------|--------------------------------------------------------------------------------|---------------------------------------|
| Marine chemoclines, anoxic or euxinic lows, bioproductivity, seawater                        | Basin chemical      | Black shale   | Black shale vanadium ± Mo ± Ni      | Metalliferous black shale, stone coal, carbonaceous marl                    | AUS: Julia Creek, QLD; CAN: Tar Sands, AB; U.S.: Gibellini V, Nev.; Phosphoria Fm. V, Mont.-Idaho-Wyo. | Granitto and others, 2017              |
| Marine chemoclines, anoxic or euxinic lows, bioproductivity, seawater                        | Basin chemical      | Black shale   | Black shale nickel ± Mo-PGE         | Metalliferous black shale                                                  | CAN: Nick Ni-Mo-PGE, YT               | Hulbert and others, 1992; Lefebure and Coveney, 1995; Gadd and others, 2020 |
| Marine chemoclines, anoxic or euxinic lows, bioproductivity, seawater                        | Basin chemical      | Black shale   | Black shale gold                    | NA                                                                          | U.S.: Upper Rodeo Au, Nev.           | Emsbo, 2000                            |
| Marine chemoclines, anoxic or euxinic lows, bioproductivity, seawater                        | Basin chemical      | Black shale   | Black shale uranium                 | NA                                                                          | U.S.: Chattanooga U, Tenn.           | IAEA, 2020                             |
| Marine chemoclines, ocean currents bioproductivity, wave base, seawater                     | Basin chemical      | Phosphorite   | Phosphorite                         | Phosphate                                                                  | AUS: Ammaroo, NT; D-Tree, QLD; Phosphate Hill/Duchess, QLD; CAN: Athabasca Basin, SK; U.S.: Phosphoria Fm., Mont.-Idaho-Wyo. | Emsbo and others, 2016a                |
| Atmospheric oxidation, oceanic oxidation event, seawater                                    | Basin chemical      | Iron formation| Superior-type banded iron formation | Lake Superior                                                              | AUS: Hamersley iron province, WA; CAN: Labrador Trough, NL and QC; U.S.: Mesabi, Minn. | Cannon, 1986b                         |
### Table 2. Deposit classification scheme.—Continued

| Genetically related features | Deposit environment | Deposit group | Deposit type | Synonym(s) | Example(s) | Reference(s) |
|-----------------------------|---------------------|---------------|--------------|------------|------------|--------------|
| Oceanic anoxic events, marine chemoclines, ocean currents, wave base, seawater | Basin chemical | Iron formation | Oolitic iron formation | Ironstone, Clinton-type, Minette-type | AUS: Train Range, QLD; CAN: Clear Hills, AB, Bell Island, NL; U.S.: Clinton, N.Y. | Maynard and Van Houten, 1992 |
| Regional-scale and intense Fe-Na-(Ca±K) metasomatism and magnetic/ gravity anomalies, caldera lakes | Basin chemical | Iron formation | Lacustrine iron formation | NA | U.S.: Upper Pilot Knob, Mo. | Nold and others, 2014 |
| Atmospheric oxidation, oceanic oxidation event, seawater | Basin chemical | Manganese | Superior-type banded manganese | Mamatwan-type; gondite | CAN: Woodstock, NB; ZAF: Kalahari | Cairncross and Beukes, 2013 |
| Oceanic anoxic events, marine chemoclines, ocean currents, wave base, seawater | Basin chemical | Manganese | Sedimentary manganese | Shelf sequence manganese, Nikopol-type manganese | AUS: Groote Eylandt and Bootu Creek, NT; UKR: Chiatura, Nikopol-Tokmak; U.S.: Cuyuna Range, Minn.; Aroostock County, Maine | Force and others, 1999; Cannon and others, 2017; Harvey and others, 2017 |
| Marine chemoclines, ocean currents, atolls and plateaus, seawater | Basin chemical | Manganese | Crust manganese | Ferromanganese crusts | U.S. EEZ: Blake Plateau | Bau and others, 2014; Mizell and Hein, 2016 |
| Marine chemoclines, ocean currents, abyssal plains, seawater | Basin chemical | Manganese | Nodule manganese | Ferromanganese nodules | U.S. EEZ: near Johnson Island, Hawaii | Hein and Koschinsky, 2014 |
| Closed lacustrine drainage basin, redox interface | Basin chemical | Manganese | Lacustrine manganese | NA | U.S.: Artillery Mountains Mn, Ariz. | Long and others, 1992 |
Table 2. Deposit classification scheme.—Continued

| Genetically related features | Deposit environment | Deposit group | Deposit type | Synonym(s) | Example(s) | Reference(s) |
|-----------------------------|---------------------|---------------|--------------|------------|------------|--------------|
| Unconformity, epicontinental basin fill, arid climate, evaporites, basin brine, extensional faults, alkali and magnesium metasomatism | Basin hydrothermal | Unconformity-related | Unconformity-related uranium | NA | AUS: Jabiluka, NT; Ranger, NT; Coronation Hill, NT; CAN: McArthur River, SK; Cigar Lake, SK; Rabbit lake, SK; Key Lake, SK | Skirrow and others, 2009 |
| | | | | | | |
| Unconformity, epicontinental basin fill, arid climate, evaporites, basin brine, extensional faults, alkali and magnesium metasomatism | Basin hydrothermal | Unconformity-related | Unconformity-related REE | NA | AUS: Browns Range, WA; CAN: Maw zone, SK | Nazari-Dehkordi and others, 2018 |
| | | | | | | |
| Collapse breccia, epicontinental basin fill, arid climate, evaporites, basin brine, extensional faults, alkali and magnesium metasomatism | Basin hydrothermal | Collapse breccia pipe | Collapse breccia pipe uranium | NA | U.S.: Grand Canyon, Ariz. | Alpine, 2010; Van Gosen and others, 2016; IAEA, 2020 |
| | | | | | | |
| Continental rift basin, initial phase, volcanics, conglomerates, and siliciclastics, arid climate, evaporites, basin brine, growth faults, salt tectonics, alkali and magnesium metasomatism | Basin hydrothermal | Volcanic-hosted | Volcanic-hosted copper | Volcanic-red bed copper; basaltic copper | CAN: Sustut, BC and Copper River, YT; U.S.: Calumet-Hecla and Kearsarge Mich. | Cox, 1986a; Lefebure and Church, 1996 |
### Table 2. Deposit classification scheme.—Continued

| Genetically related features                                                                 | Deposit environment | Deposit group          | Deposit type               | Synonym(s)                                                                 | Example(s)                                                                 | Reference(s)                  |
|--------------------------------------------------------------------------------------------|---------------------|------------------------|----------------------------|-----------------------------------------------------------------------------|----------------------------------------------------------------------------|--------------------------------|
| Continental rift basin, initial phase, volcanics, conglomerates and siliciclastics, arid climate, evaporites, basin brine, growth faults, salt tectonics, alkali and magnesium metasomatism | Basin hydrothermal  | Sediment-hosted        | Sediment-hosted copper ± Co | Sediment-hosted Cu-Ag-Co, shale-hosted Cu, Kupferschiefer-type, redbed Cu | AUS: Nifty, WA; CAN: Redstone, NT; COD: copper belt; DEU: Kupferschiefer district U.S.: White Pine, Mich.; Rock Creek and Montanore, Mont. | Hayes and others, 2015         |
| Continental rift basin, fill phase, turbidite sequences, arid climate, evaporites, growth faults, mafic magmatism, basinal brine, alkali and magnesium metasomatism, seafloor vents | Basin hydrothermal  | Sediment-hosted        | Siliciclastic-mafic zinc-lead | Metamorphosed SEDEX, CD, Sullivan-type, Broken Hill-type (BHT) | AUS: Broken Hill, NSW; Cannington, QLD; CAN: Sullivan and Keichika Trough, BC; MacMillan Pass, YT | Lydon and others, 2000; Spry and Teale, 2021 |
| Continental rift basin, fill phase, turbidite sequences, arid climate, evaporites, growth faults, mafic magmatism, basinal brine, alkali and magnesium metasomatism, seafloor vents | Basin hydrothermal  | Sediment-hosted        | Siliciclastic-mafic barite   | NA                                                                          | U.S.: Northumberland barite, Nev.                                         | Clark and Orris, 1991          |

[ACT, Australian Capital Territory; Ag, silver; Al, aluminum; Ala., Alabama; Ariz., Arizona; As, arsenic; Au, gold; AUS, Australia; AZE, Azerbaijan; B, boron; BC, British Columbia; Be, beryllium; BHT, Broken Hill type; Bi, bismuth; BOL, Bolivia; BRA, Brazil; Ca, calcium; Calif., California; CAN, Canada; CD, clastic-dominated; CHL, Chile; CHN, China; Co, cobalt; CO₂, carbon dioxide; COD, Democratic Republic of the Congo; Colo., Colorado; Cr, chromium; CRI, Costa Rica; Cu, copper; CUB, Cuba; DEU, Germany; EEZ, Exclusive Economic Zone; ESP, Spain; EU, European Union; Fe, iron; Fiji; FIN, Finland; Fm., Formation; GBR, United Kingdom of Great Britain and Northern Ireland; HFSE, high field strength elements; Hg, mercury; HS, high sulfidation; H₂S, hydrogen sulfide; Ill., Illinois; IND, India; IOA, iron oxide-apatite; IOCG, iron oxide-copper-gold; IRA, Ireland; IS, intermediate sulfidation; ISCG, iron sulfide-copper-gold; ITA, Italy; JPN, Japan; K, potassium; Ky., Kentucky; LCT, lithium-cesium-tantalum; Li, lithium; LIP, large igneous province; LS, low sulfidation; MB, Manitoba; MEX, Mexico; Mg, magnesium; Mich., Michigan; Minn., Minnesota; Mn, manganese; MNG, Mongolia; Mo, molybdenum; Mo., Missouri; Mont., Montana; MRT, Mauritania; MT, magnetotelluric; MVT, Mississippi Valley type; Na, sodium; NA, not applicable; Nb, niobium; NB, New Brunswick; N. Dak., North Dakota; Ne., Nevada; NGA, Nigeria; Ni, nickel; N.J., New Jersey; NL, Newfoundland and Labrador; N. Mex., New Mexico; NS, Nova Scotia; NSW, New South Wales; NT, Northern Territory in AUS and Northwest Territories in CAN; NU, Nunavut; N.Y., New York; NYF, niobium-yttrium-fluorine; Okla., Oklahoma; ON, Ontario; Ore., Oregon; Pb, lead; PER, Peru; PGE, platinum group elements; PHL, Philippines; PNG, Papua New Guinea; QC, Quebec; QLD, Queensland; REE, rare earth elements; RUS, Russia; SA, South Australia; SAU, Saudi Arabia; SCLM, subcontinental lithospheric mantle; S. Dak., South Dakota; SEDEX, sedimentary exhalative; SK, Saskatchewan; SMS, seafloor massive sulfide; Sn, tin; So. Am., South America; SWE, Sweden; Ta, tantalum; TAS, Tasmania; Te, tellurium; Tenn., Tennessee; Tex., Texas; Th, thorium; Ti, titanium; TUR, Turkey; U, uranium; UKR, Ukraine; U-M, ultramafic and (or) mafic; U.S., United States; V, vanadium; VAMS, volcanic-associated massive sulfide; YEN, Venezuela; VMS, volcanogenic massive sulfide; VHMS, volcanic-hosted massive sulfide; VIC, Victoria; W, tungsten; WA, Western Australia; Wash., Washington; W. Va., West Virginia; Wix., Wisconsin; Wyo., Wyoming; YT, Yukon Territory; ZAF, South Africa; Zn, zinc; ZWE, Zimbabwe]
Table 2. Deposit classification scheme.—Continued

| Genetically related features | Deposit environment | Deposit group | Deposit type | Synonym(s) | Example(s) | Reference(s) |
|-----------------------------|---------------------|---------------|--------------|------------|------------|--------------|
| Continental rift (or passive margin) basin, sag phase, carbonate shelf and siliciclastic slope sequences, arid climate, evaporites, growth faults, basin brine, alkali and magnesium metasomatism, seafloor vents | Basin hydrothermal | Sediment-hosted | Siliciclastic-carbonate zinc-lead | Sedex, CD, McArthur, bedded | AUS: Mt. Isa, QLD; McArthur River, NT; CAN: Howard's Pass, YT; U.S.: Red Dog Zn, Alaska; Balmat-Edwards Zn-Pb, N.Y. | Emsbo, 2009; Emsbo and others, 2016b |
| Continental rift (or passive margin) basin, sag phase, carbonate shelf and siliciclastic slope sequences, arid climate, evaporites, growth faults, basin brine, alkali and magnesium metasomatism, seafloor vents | Basin hydrothermal | Sediment-hosted | Irish-type sediment-hosted zinc-lead | NA | IRE: Irish zinc belt (Navan, Lisheen, Tynagh, Silvermines, Galmoy, Ballinalack) | Hitzman, 1995; Höy, 1996 |
| Continental rift basin, initial phase, conglomerates and siliciclastics, arid climate, evaporites, basin brine, growth faults, salt tectonics, alkali and magnesium metasomatism, seafloor vents | Basin hydrothermal | Sediment-hosted | Kipushi-type sediment-hosted copper-zinc-lead | Kipushi, salt dome | U.S.: Ruby Creek, Alaska; Apex, Utah | Cox and Bernstein, 1986; De Magnee and Francois, 1988 |
| Contractional orogeny, foreland basin, forebulge faults, arid climate, evaporites, basin brine, alkali and magnesium metasomatism | Basin hydrothermal | Mississippi Valley-type (MVT) | MVT zinc-lead | NA | AUS: Lennard Shelf, WA; Admiral Bay, WA; CAN: Polaris and Nanisivik, NU; Pine Point, NT; Robb Lake, BC; Gays River, NS; U.S.: Viburnum trend, Mo. | Leach and others, 2010 |
| Genetically related features | Deposit environment | Deposit group | Deposit type | Synonym(s) | Example(s) | Reference(s) |
|-----------------------------|---------------------|--------------|-------------|------------|------------|--------------|
| Contractional orogeny, foreland basin, forebulge faults, arid climate, evaporites, basin brine, alkali and magnesium metasomatism | Basin hydrothermal | Mississippi Valley-type (MVT) | MVT barite | NA | CAN: Walton, NS; U.S.: SE Missouri barite district | Leach and others, 2010 |
| Contractional orogeny, foreland basin, forebulge faults, arid climate, evaporites, basin brine, alkali and magnesium metasomatism | Basin hydrothermal | Mississippi Valley-type (MVT) | MVT fluor spar | NA | CAN: Liard, BC; U.S.: Illinois-Kentucky fluor spar | Plumlee and others, 1995; Denny and others, 2015, 2016; Hayes and others, 2017 |
| Contractional orogeny, foreland basin, forebulge faults, arid climate, evaporites, basin brine, alkali and magnesium metasomatism | Basin hydrothermal | Mississippi Valley-type (MVT) | MVT strontium | NA | TUR: Sivas basin celestite | Ucurum and others, 2017 |
| Contractional orogeny, foreland basin, forebulge faults, arid climate, evaporites, basin brine, alkali and magnesium metasomatism | Basin hydrothermal | Mississippi Valley-type (MVT) | Sandstone-hosted zinc-lead | NA | CAN: Wigwam, BC; George Lake, SK; SWE: Laisvall Zn-Pb | Briskey, 1986 |
| More oxidized and (or) meta-morphosed equivalents of features noted in the previous row | Basin hydrothermal | Non-sulfide | Non-sulfide zinc-lead ± Mn | Oxide zinc | AUS: Beltana, SA; BRA: Vazante; U.S.: Franklin-Sterling Hill, N.J. | Hitzman and others, 2003 |
Table 2. Deposit classification scheme.—Continued

| Genetically related features | Deposit environment | Deposit group | Deposit type | Synonym(s) | Example(s) | Reference(s) |
|-----------------------------|--------------------|--------------|-------------|------------|------------|--------------|
| Crystalline basement, extensional faults, basin brine, natural gas, redox interface, hydrolytic ± CO₂ metasomatism, arsenides, regional iron and alkali-calcic metasomatism | Basin hydrothermal | Five-element | Vein five-element | Ag-Bi-Co-Ni arsenide | CAN: Beaver and Timiskaming, ON; Cobalt, ON; Silver Islet, ON; Echo Bay and Eldorado, NT; U.S.: Wickenburg, Ariz.; Black Hawk, N Mex. | Kissin, 1992; Mumin and others, 2010; Markl and others, 2016; Burisch and others, 2019; Corriveau and others, in press |
| Contractional orogen, metamorphic belts, dilatant structures, metamorphic fluid, hydrolytic, CO₂, H₂S metasomatism | Metamorphic hydrothermal | Orogenic | Hypozonal orogenic gold | Mesothermal gold; low-sulfide gold-quartz vein, shear zone gold | CAN: Borden Lake, ON | Groves and others, 1998; Goldfarb and others, 2005, 2016 |
| Contractional orogen, metamorphic belts, dilatant structures, metamorphic fluid, hydrolytic, CO₂, H₂S metasomatism | Metamorphic hydrothermal | Orogenic | Mesozonal orogenic gold | Mesothermal gold; low-sulfide gold-quartz vein, shear zone gold | AUS: Golden Mile, WA; Bendigo, VIC; CAN: Sigma, QC; Timmins and Detour Lake, ON; Bridge River, BC; U.S.: Mother Lode, Calif.; Alaska-Juneau, Alaska | Groves and others, 1998; Goldfarb and others, 2005, 2016 |
| Contractional orogen, metamorphic belts, dilatant structures, metamorphic fluid, hydrolytic, CO₂, H₂S metasomatism | Metamorphic hydrothermal | Orogenic | Epizonal orogenic gold | Refractory orogenic gold, Carlin-style gold | AUS: Wiluna, WA; Fosterville, QLD; CAN: Rackla and Coffee, YT; CHN: Qiluling; U.S.: Donlin Creek, Alaska | Groves and others, 1998; Goldfarb and others, 2005, 2016 |
| Genetically related features | Deposit environment | Deposit group | Deposit type | Synonym(s) | Example(s) | Reference(s) |
|-----------------------------|--------------------|--------------|--------------|------------|------------|--------------|
| Contractional orogen, metamorphic belts, dilatant structures, metamorphic fluid, hydrolytic, CO₂ ± H₂S metasomatism | Metamorphic hydrothermal | Orogenic | Epizonal orogenic antimony ± gold | NA | AUS: Hillgrove, NSW; CAN: Bridge River-Bralorne, BC; U.S.: U.S. Antimony Mine, Mont. | Bliss and Orris, 1986; Groves and others, 1998; Goldfarb and others, 2005, 2016; Hofstra and others, 2013 |
| Contractional orogen, metamorphic belts, dilatant structures, metamorphic fluid, hydrolytic, CO₂ ± H₂S metasomatism | Metamorphic hydrothermal | Orogenic | Epizonal orogenic mercury | NA | CAN: Pinchi Lake, BC; U.S.: Southwest, Alaska | Gray and Bailey, 2003 |
| Contractional orogen, metamorphic belts, dilatant structures, metamorphic fluid, hydrolytic, CO₂ ± H₂S metasomatism | Metamorphic hydrothermal | Orogenic | Orogenic silver-lead-zinc-copper-antimony | NA | AUS: Endeavor (Elura), NSW; Woodcutters, NT; U.S.: Coeur d’Alene district, Idaho-Mont. | Leach and others, 1988, 1998; Beaudoin and Sangster, 1992, 1995 |
| Contractional orogen, metamorphic belts, dilatant structures, metamorphic fluid, hydrolytic, CO₂ ± H₂S, alkali metasomatism | Metamorphic hydrothermal | Orogenic | Orogenic copper ± gold | NA | AUS: Cobar, NSW; Mt. Isa Cu, QLD | Lawrie and Hinman, 1998 |
| Contractional orogen, metamorphic belts, dilatant structures, metamorphic fluid, carbon metasomatism | Metamorphic hydrothermal | Orogenic | Orogenic graphite vein, lump graphite | CAN: Buckingham, QC; Lacs-des-îles, QC; Calumet, QC; Miller, QC; U.S.: Crystal Graphite, Mont. | Luque and others, 2014; Simandl and others, 2015 |
| Genetically related features | Deposit environment | Deposit group | Deposit type | Synonym(s) | Example(s) | Reference(s) |
|-----------------------------|--------------------|--------------|--------------|------------|-----------|--------------|
| Regional metamorphic belts  | Metamorphic        | Metamorphic  | Metamorphic graphite | Flake graphite, amorphous graphite | AUS: Campoona Shaft, SA; CAN: Lac Knife, QC; U.S.: Graphite Cr. Alaska; Alabama Graphite, Ala. | Luque and others, 2014; Simandl and others, 2015 |
| Regional metamorphic belts  | Metamorphic        | Metamorphic  | Metamorphic kyanite | NA | CAN: Crocan Lake, ON; U.S.: Dillwyn, Va. | Marr, 1992 |
| Continental arc or rift, mafic to felsic or alkalic magmatism, sedimentary basins, dilatant faults, magmatic and basinal or lacustrine brines, iron alkali calcic metasomatism, high amplitude magnetic, gravity, and MT anomalies | Regional metasomatic | Alkali-calcic | Low Iron alkali-calcic | NA | AUS: Merlin Mo-Re, Mount Dore Cu-Ag-Au-Zn, Tick Hill Au, QLD; BRA: Alvo 118 Cu-Au | Xavier and others, 2012; Babo and others, 2017; Le, 2019 |
| Continental arc or rift, mafic to felsic or alkalic magmatism, sedimentary basins, dilatant faults, magmatic and basinal or lacustrine brines, iron alkali calcic metasomatism, high amplitude magnetic, gravity, and MT anomalies | Regional metasomatic | Alkali-calcic | Albite-hosted uranium | Albite-type metasomatic U | AUS: Valhalla U, QLD; CAN: Michelin U, NL | Gandhi, 1978; Polito and others, 2009; Sparkes and others, 2017 |
Table 2. Deposit classification scheme.—Continued

| Genetically related features | Deposit environment | Deposit group          | Deposit type                        | Synonym(s) | Example(s)                                                                 | Reference(s) |
|------------------------------|---------------------|------------------------|-------------------------------------|------------|-----------------------------------------------------------------------------|--------------|
| Continental arc or rift, mafic to felsic or alkalic magmatism, sedimentary basins, dilatant faults, magmatic and basinal or lacustrine brines, iron alkali calcic metasomatism, high amplitude magnetic, gravity, and MT anomalies | Regional metasomatic | Metasomatic iron                   | Ferroan carbonate polymetallic | NA         | MRT: Guelb Moghrein Cu-Au                                                  | Kirschbaum and Hitzman, 2016 |
|                             |                     |                        |                                     |            | AUS: Lorena Co-As-Bi-Au, Mount Cobalt Co-As, QLD; CAN: Delhi Pacific Cu-Ag-Au, QC; IND: Akwali Cu; U.S.: Iron Creek Co-Cu, Idaho | Sarkar and Dasgupta, 1980; McLaughlin and others, 2016; Ristorcelli and Schlitt, 2019 |
|                             |                     |                        |                                     |            | BRA: Sossegos Cu-Au-Ag; CAN: Scadding Au, ON; FIN: Haveri Au; PER: Raul-Condestable Cu-Au-Ag; U.S.: Blackbird Co-Cu-Au, Idaho | Strauss, 2003; De Haller and others, 2006; Schandl and Gorton, 2007; Monteiro and others, 2008; Slack, 2013; Corriuwe and others, in press |
Table 2. Deposit classification scheme.—Continued

| Genetically related features | Deposit environment | Deposit group | Deposit type | Synonym(s) | Example(s) | Reference(s) |
|-----------------------------|---------------------|---------------|--------------|------------|------------|--------------|
| Continental arc or rift, mafic to felsic or alkalic magmatism, sedimentary basins, dilatant faults, magmatic and basinal or lacustrine brines, iron alkali calcic metasomatism, high amplitude magnetic, gravity, and MT anomalies | Regional metasomatic | Metasomatic iron | Iron oxide poly-metallic | NA | BRA: Jatoba Ni; CAN: NICO Au-Co-Bi-Cu, NT; U.S.: Iron Creek Co-Cu, Idaho | Slack, 2013; Acosta-Góngora and others, 2015; Montreuil and others, 2016; Ristorcelli and Schlitt, 2019; Veloso and others, 2020 |
| Continental arc or rift, mafic to felsic or alkalic magmatism, sedimentary basins, dilatant faults, magmatic and basinal or lacustrine brines, iron alkali calcic metasomatism, high amplitude magnetic, gravity, and MT anomalies | Regional metasomatic | Metasomatic iron | Iron oxide uran- nium | NA | AUS: Mount Gee U, SA; CAN: Southern Breccia U, NT | Youles and Oilmin, 1986; Montreuil and others, 2015 |
| Continental arc or rift, mafic to felsic or alkalic magmatism, sedimentary basins, dilatant faults, magmatic and basinal or lacustrine brines, iron alkali calcic metasomatism, high amplitude magnetic, gravity, and MT anomalies | Regional metasomatic | Metasomatic iron | Iron oxide gold | NA | AUS: Prominent Hill Au, SA; White Devil Au-Cu-Bi, Noble Nob Au, Juno Au-Cu-Bi-Ag, NT; U.S.: Detachment Au, Calif. | Schandl and Gorton, 2007; Spencer and Duncan, 2015 |
| Genetically related features                                                                 | Deposit environment | Deposit group | Deposit type                  | Synonym(s) | Example(s)                                                                 | Reference(s)                      |
|---------------------------------------------------------------------------------------------|---------------------|---------------|-------------------------------|------------|---------------------------------------------------------------------------|----------------------------------|
| Continental arc or rift, mafic to felsic or alkalic magmatism, sedimentary basins, dilatant faults, magmatic and basinal or lacustrine brines, iron alkali calcic metasomatism, high amplitude magnetic, gravity, and MT anomalies | Regional metasomatic | IOCG          | Hematite-dominant IOCG        | NA         | AUS: Olympic Dam Cu-Au-Ag-U; Prominent Hill Cu-Au; Carrapateena Cu-Au; Oak Dam West, SA; CHL: Mantoverde Cu-Au | Rieger and others, 2010; Skirrow, 2010; Ehrig and others, 2012; Oz Minerals, Ltd., 2013; Schlegel and Heinrich, 2015; King, 2019 |
| Continental arc or rift, mafic to felsic or alkalic magmatism, sedimentary basins, dilatant faults, magmatic and basinal or lacustrine brines, iron alkali calcic metasomatism, high amplitude magnetic, gravity, and MT anomalies | Regional metasomatic | IOCG          | Magnetite-dominant IOCG       | NA         | AUS: Ernest Henry Cu-Au, QLD; BRA: Salobo Cu-Au-Ag; CAN: Sue Dianne, NT; CHL: Candelaria; CHN Dahongshan Fe-Cu-(Ag-Au); MRT: Guelb Morghen Cu-Co-Au; U.S.: Boss-Bixby Cu, Mo.; Yerington Cu, Nev.; Lights Creek Cu, Calif. | Barton and others, 2000; Marschik and Fontboté, 2001; Camier, 2002; Mark and others, 2006; Munin and others, 2010; Kirschbaum and Hitzman, 2016; deMelod and others, 2017; Zhao and others, 2017 |
| Continental arc or rift, mafic to felsic or alkalic magmatism, sedimentary basins, dilatant faults, magmatic and basinal or lacustrine brines, iron alkali calcic metasomatism, high amplitude magnetic, gravity, and MT anomalies | Regional metasomatic | IOA           | Hematite-dominant IOA         | NA         | AUS: Oak Dam Fe; U.S.: Iron Mtn., Mo.; Cortez Mtns., Nev.                  | Barton and others, 2000; Davidson and others, 2007 |
Table 2. Deposit classification scheme.—Continued

| Genetically related features | Deposit environment | Deposit group | Deposit type | Synonym(s) | Example(s) | Reference(s) |
|-----------------------------|--------------------|--------------|--------------|------------|------------|--------------|
| Continental arc or rift, mafic to felsic or alkalic magmatism, sedimentary basins, dilatant faults, magmatic and basinal or lacustrine brines, iron alkali calcic metasomatism, high amplitude magnetic, gravity, and MT anomalies | Regional metasomatic | IOA | Magnetite-dominant IOA | NA | AUS: Lightning Creek Fe, QLD; CAN: Josette Fe-REE, Marmoraton Fe, and Lac Marmont Fe, QC; Mag Hill Fe-(REE-V) and Terra Fe-(REE), NT; CHL: El Laco Fe; CHN: Middle-Lower Yangtz River Metallization Belt; PER: Marcona Fe; SWE: Kiirunavuara Fe, U.S.: Pea Ridge, Mo.; Mineville Fe-REE, N.Y.; Humboldt complex, Nev. | McKeown and Klemic, 1956; Leonard and Buddington, 1964; Hildebrand, 1986; Hannington, Johnson and Barton, 2000; Perring and others, 2000; Edfelt and others, 2005; Clark and others, 2010; Mumin and others, 2016; Yu and others, 2011; Harlov and others, 2016; Tornos and others, 2017; Corriveau and others, in press; Zhao and others, in press |
| Oceanic rift or arc volcanism, ±fluid exsolution, dilatant faults, convecting seawater, seafloor vents | Volcanic basin hydrothermal | Volcanogenic massive sulfide (VMS) | Mafic-ultramafic VMS | Volcanic-hosted massive sulfide (VHMS), volcanic-associated massive sulfide (VAMS), seafloor massive sulfide (SMS), Cyprus-type | CAN: Betts Cove, York Harbour, and Tilt Cove, NL; Potterdoraf, ON; Chu Chua, BC; Norway: Lokken; U.S.: Turner-Albright, Oreg. | Shanks and Thurston, 2012; Hannington, 2014; Monecke and others, 2016 |
Table 2. Deposit classification scheme.—Continued

| Genetically related features                                                                 | Deposit environment | Deposit group                                   | Deposit type                                      | Synonym(s)                              | Example(s)                                                                 | Reference(s) |
|------------------------------------------------------------------------------------------------|---------------------|-------------------------------------------------|--------------------------------------------------|-----------------------------------------|---------------------------------------------------------------------------|--------------|
| Oceanic rift or arc volcanism, ±fluid exsolution, dilatant faults, convecting seawater, seafloor vents | Volcanic basin hydrothermal | Volcanogenic massive sulfide (VMS)             | Mafic-siliciclastic                              | Volcanic-hosted massive sulfide (VHMS), volcanic-associated massive sulfide (VAMS), seafloor massive sulfide (SMS), Besshi-type | AUS: Tritton, NSW; De-Grussa, WA; CAN: Windy Craggy, BC; Goldstream, BC; Standard, BC; True Blue, BC; JPN: Besshi; U.S.: Ducktown, Tenn. | Shanks and Thurston, 2012; Hannington, 2014; Monecke and others, 2016 |
| Oceanic rift or arc volcanism, ±fluid exsolution, dilatant faults, convecting seawater, seafloor vents | Volcanic basin hydrothermal | Volcanogenic massive sulfide (VMS)             | Bimodal-mafic                                    | Volcanic-hosted massive sulfide (VHMS), volcanic-associated massive sulfide (VAMS), seafloor massive sulfide (SMS), Noranda-type | AUS: Mount Lyell, TAS; Sulphur Springs, WA; CAN: Horne, Quemont, and Noranda, QC; Kidd Creek, ON; Flin Flon, MB; Buchans, NL; Bathurst-Newcastle, NB; JPN: Kuroko; Spain: Rio Tinto; Sweden: Kristieberg; U.S.: Shasta King, Calif.; Lockwood, Wash.; Bald Mountain, Maine | Shanks and Thurston, 2012; Hannington, 2014; Monecke and others, 2016 |
| Oceanic rift or arc volcanism, ±fluid exsolution, dilatant faults, convecting seawater, seafloor vents | Volcanic basin hydrothermal | Volcanogenic massive sulfide (VMS)             | Bimodal felsic                                   | Volcanic-hosted massive sulfide (VHMS), volcanic-associated massive sulfide (VAMS), seafloor massive sulfide (SMS), Kuroko-type | AUS: Rosebery, Mount Read, TAS; Gossan Hill, WA; CAN: Myra Falls, BC; Eskay Creek, BC; Iok Lake, NU; CHN: Gacun; JPN: Hokuroku; U.S.: Jerome, Ariz. | Shanks and Thurston, 2012; Hannington, 2014; Monecke and others, 2016 |
Table 2. Deposit classification scheme.—Continued

| Genetically related features | Deposit environment | Deposit group | Deposit type | Synonym(s) | Example(s) | Reference(s) |
|-----------------------------|--------------------|---------------|-------------|------------|------------|---------------|
| Oceanic rift or arc volcanism, ±fluid exsolution, dilatant faults, convecting seawater, seafloor vents | Volcanic basin hydrothermal | Volcanogenic | Massive sulfide (VMS) | Can. Bathurst, NB; Brunswick No 12, NB; ESP: Iberian Pyrite Belt; U.S.: Bonnifield, Alaska | Shanks and Thurston, 2012; Hannington, 2014; Monecke and others, 2016 |
| Oceanic rift or arc volcanism, ±fluid exsolution, dilatant faults, convecting seawater, seafloor vents | Volcanic basin hydrothermal | Volcanogenic | Algoma-type banded iron formation | Volcanic iron formation | AUS: Koongie Park Formation, WA; BRA: Carajas; CAN: Mary River, NU; Helen Mine, ON; Sherman, ON; Adams, ON; Griffith, ON; Iron Hill, ON; Adam River, ON; Woodstock, NB; Austin Brook, NB; IND: Kudremuk; U.S.: Vermilion, Minn.; VEN: Cerro Bolivar | Cannon, 1986a |
| Oceanic rift or arc volcanism, ±fluid exsolution, dilatant faults, convecting seawater, seafloor vents | Volcanic basin hydrothermal | Volcanogenic | Volcanogenic manganese | Franciscan, Cuban, Olympic Peninsula, and Cyprus manganese | CAN: Mary River, NU; Helen Mine, ON; Sherman, ON; Adams, ON; Griffith, ON; Iron Hill, ON; Adam River, ON; Woodstock, NB; Austin Brook, NB; IND: Kudremuk; U.S.: Vermilion, Minn.; VEN: Cerro Bolivar | Mosier and Page, 1988 |
| Occurs in more than one system type | Magmatic hydrothermal | Epithermal | Low-sulfidation (LS) epithermal gold-silver | Adularia-sericite gold-silver; hot-spring gold-silver; epizonal intrusion-related gold | AUS: Pajingo, QLD; Cracow, QLD; CAN: Mallery Lake, NU; Bakers Mine, BC; Lawyers, BC; U.S.: Sleeper, Nev. | John, 2001; Simmons and others, 2005 |
Table 2. Deposit classification scheme.—Continued

| Genetically related features | Deposit environment | Deposit group | Deposit type | Synonym(s) | Example(s) | Reference(s) |
|-----------------------------|--------------------|---------------|--------------|------------|------------|--------------|
| Occurs in more than one system type | Magmatic hydrothermal | Epithermal | Intermediate-sulfidation (IS) epithermal silver-gold ± Zn, Pb, Cu, Sn, Mn | Adularia-sericite silver-gold | AUS: Lake Cowal, NSW; CAN: Silbak-Premier, BC; U.S.: Comstock and Tonopah, Nev.; Creede, Colo. | Sillitoe and Hedenquist, 2003; Simmons and others, 2005 |
| Occurs in more than one system type | Magmatic hydrothermal | Epithermal | High-sulfidation (HS) epithermal silver-gold ± Cu | Quartz-alunite gold, enargite-gold | AUS: Mt. Carlton, QLD; U.S.: Goldfield, Nev. | Sillitoe and Hedenquist, 2003; Simmons and others, 2005 |
| Arc or rift, alkaline volcanic-plutonic center, magmatic fluid, alkali and hydrolytic metasomatism | Magmatic hydrothermal | Epithermal | Alkalic epithermal gold ± Ag | Au-Ag-Te veins | FIJI: Emperor; PNG: Porgera; U.S.: Cripple Creek, Colo. | Jensen and Barton, 2000; Kelley and Spry, 2016; Kelley and others, 2020 |
| Occurs in more than one system type | Magmatic hydrothermal | Epithermal | Epithermal mercury | Hot spring Hg | U.S.: McDermitt, Nev. | Rytuba, 1986 |
| Continental rift, hydrous bimodal magmatism, A-type volcanic-plutonic center, magmatic fluid, meteoric water | Magmatic hydrothermal | Epithermal | Epithermal beryllium | Volcanogenic Be | U.S.: Spor Mtn., Utah | Barton and Young, 2002; Foley and others, 2012 |
| Continental rift, hydrous bimodal magmatism, A-type volcanic-plutonic center, magmatic fluid, meteoric water | Magmatic hydrothermal | Epithermal | Epithermal uranium | Volcanogenic U, volcanic-related U | AUS: Ben Lomond, QLD; CAN: Sagar, QC; U.S.: Marysvale, Utah; Anderson Mine, Ariz. | Nash, 2010; Andrews and Parker, 2017; IAEA, 2020 |
| Occurs in more than one system type | Magmatic hydrothermal | Vein | Vein ± replacement nickel | Avebury-style Ni, ophiolite-hosted Ni, hydrothermal Ni | AUS: Avebury, TAS | Callaghan and others, 2017 |
Table 2. Deposit classification scheme.—Continued

| Genetically related features | Deposit environment | Deposit group | Deposit type | Synonym(s) | Example(s) | Reference(s) |
|-----------------------------|---------------------|---------------|--------------|------------|------------|--------------|
| Occurs in more than one system type | Magmatic hydrothermal | Vein | Vein cobalt ± Ni | Hydrothermal Ni-Co-As | MRT: Bou Azzer | Ahmed and others, 2009 |
| Occurs in more than one system type | Magmatic hydrothermal | Vein | Vein copper | NA | AUS: Cayley, VIC; CAN: Temagami, ON; U.S.: Magma, Ariz. | Friehauf and Pareja, 1998 |
| Continental back arc or hinterland, S-type volcano-plutonic center, magmatic fluid, alkali and hydrolytic metasomatism | Magmatic hydrothermal | Vein | Vein tin | Cornwall-type | CAN: Kalzas, YT; Mount Pleasant, NB; GBR: Cornwall | Reed, 1986e |
| Continental back arc or hinterland, S-type volcano-plutonic center, magmatic fluid, alkali and hydrolytic metasomatism | Magmatic hydrothermal | Vein | Vein tungsten | NA | CAN: Burnt Hill, NB; PER: Pasto Bueno | Cox and Bagby, 1986 |
| Continental back arc or hinterland, S-type volcano-plutonic center, magmatic fluid, alkali and hydrolytic metasomatism | Magmatic hydrothermal | Vein | Vein tin polymetallic | Bolivian-type | AUS: Baal Gammon, QLD; BOL: Oruro | Togashi, 1986 |
| Occurs in more than one system type | Magmatic hydrothermal | Vein | Vein fluorite | Flourspar | AUS: Meenetheena and Speewah, WA; U.S.: Western Kentucky | Anderson, 2019 |
| Occurs in more than one system type | Magmatic hydrothermal | Vein | Vein polymetallic | NA | CAN: Hector-Calumet and Elsa, Mayo district, YT; Slocan-New Denver-Ainsworth district, BC | Cox, 1986d |
Table 2. Deposit classification scheme.—Continued

| Genetically related features | Deposit environment | Deposit group | Deposit type | Synonym(s) | Example(s) | Reference(s) |
|-----------------------------|---------------------|---------------|--------------|------------|------------|--------------|
| Occurs in more than one system type | Magmatic hydrothermal | Breccia pipe | Breccia pipe copper | Igneous-hydrothermal breccia | CAN: Tribag, ON; Croxall, ON; CHL: El Teniente | Skewes and others, 2002; Stern and others, 2011 |
| Continental back arc or hinterland, regional felsic magmatism of ilmenite to magnetite series, magmatic fluid, alkali and hydrolytic metasomatism | Magmatic hydrothermal | Breccia pipe | Breccia pipe gold | Intrusion-related gold | AUS: Kidston, QLD; Mt. Leyshon, QLD | Baker and Andrew, 1991; Allan and others, 2011 |
| Continental rift, hydrous bimodal magmatism, A-type volcano-plutonic center, magmatic fluid | Magmatic hydrothermal | Breccia pipe | Breccia pipe molybdenum | NA | U.S.: Cave Peak Mo, Tex. | Sharp, 1979 |
| Arc or rift, alkaline volcano-plutonic center, magmatic fluid, alkali and hydrolytic metasomatism | Magmatic hydrothermal | Breccia pipe | Breccia pipe REE | NA | U.S.: Pea Ridge REE, Mo. | Nuelle and others, 1991 |
| Slab rollback, arc migration, magmatic volatiles, extensional faults, reduced slope facies, meteoric water, CO₂, H₂S and hydrolytic metasomatism, jasperoids | Magmatic hydrothermal | Carlin-type | Carlin-type gold | Sediment-hosted disseminated gold, sediment-hosted micron gold | CAN: Rackla, YT; CHN: Golden triangle; U.S.: Carlin trend, Battle Mt.-Eureka trend, Getchell trend, Nev. | Hofstra and Cline, 2000; Cline and others, 2005; Muntean, 2018 |
| Occurs in more than one system type | Magmatic hydrothermal | Distal-disseminated | Distal-disseminated silver-gold | Carlin-like, Carlin-style | U.S.: Lone Tree Ag-Au, Nev. | Cox, 1992 |
Table 2. Deposit classification scheme.—Continued

| Genetically related features | Deposit environment | Deposit group | Deposit type | Synonym(s) | Example(s) | Reference(s) |
|------------------------------|---------------------|---------------|--------------|-----------|------------|--------------|
| Occurs in more than one system type | Magmatic hydrothermal | Replacement | Replacement polymetallic | NA | CAN: Midway, BC; Bluebell, BC; Sa Dena Hes, YT; MEX: Santa Eulalia, Naica, Fresnillo, Velardena, Providencia; U.S.: Leadville district, Colo.; East Tintic district, Utah; Eureka district, Nev. | Morris, 1986; Titley, 1997 |
| Occurs in more than one system type | Continent back arc or hinterland, S-type volcano-plutonic center, magmatic fluid, alkali and hydrolytic metasomatism | Magmatic hydrothermal | Replacement | Replacement gold-silver | Sulfide manto Au | CAN: Ketza River, YT; Mosquito Creek, BC | Abercrombie, 1990 |
| Occurs in more than one system type | Magmatic hydrothermal | Replacement | Replacement tin | NA | AUS: Renison, TAS; CAN: Mount Pleasant, NB | Reed, 1986c; Hammarstrom and others, 1995a |
| Occurs in more than one system type | Magmatic hydrothermal | Replacement | Replacement copper | NA | U.S.: Bisbee, Ariz. | Stegen and others, 2005 |
| Occurs in more than one system type | Magmatic hydrothermal | Replacement | Replacement zinc-lead | NA | U.S.: Bingham Canyon, Tintic, Park City, Deer Trail, Utah; Pima, Ariz. | Beaty and others, 1986; Titley, 1997 |
| Occurs in more than one system type | Magmatic hydrothermal | Replacement | Replacement manganese | NA | U.S.: Butte, Mont.; Leadville, Colo. | Mosier, 1986 |
| Occurs in more than one system type | Arc, magnetite series, calc-alkaline volcano-plutonic center, magmatic fluid, alkali and hydrolytic metasomatism | Magmatic hydrothermal | Replacement | Replacement magnesian | Crystalline magnesite | CAN: Mount Bussilof, BC; U.S.: Premier Magnesia (Gabbs), Nev. | Page, 1998a; Simandl and Hancock, 1999 |
Table 2. Deposit classification scheme.—Continued

| Genetically related features | Deposit environment | Deposit group | Deposit type | Synonym(s) | Example(s) | Reference(s) |
|-----------------------------|---------------------|---------------|--------------|------------|------------|--------------|
| Occurs in more than one system type | Magmatic hydrothermal | Replacement | Replacement fluorite | NA | U.S.: McCulloughs Butte, Nev. | Barton, 1982 |
| Occurs in more than one system type | Magmatic hydrothermal | Skarn | Skarn iron | NA | AUS: Paddys River, ACT; AZE: Dashkesan; CAN: Tasu, Jessie, Merry Widow, Iron Crown, Iron Hill, Yellow Kid, and Prescott, BC; CHN: Jinshandian, Middle Lower-Yangtze River Metallogenic Belt; CUB: Daiquiri; ITA: San Leone; JPN: Shinyama; RUS: Magnitogorsk, Perschansk, Sheregesh, and Teya; U.S.: Santa Rita, N. Mex.; Cornwall Iron Springs, Utah; Eagle Mountain, Calif. | Cox, 1986c; Hammarstrom and others, 1995c; Meinert and others, 2005; Zeng and others, 2020 |
| Occurs in more than one system type | Magmatic hydrothermal | Skarn | Skarn copper | NA | CAN: Craigmont, BC; Phoenix, BC; Old Sport, BC; Queen Victoria, BC; Mines Gaspé, QC; U.S.: Copper Canyon, Nev.; Carr Fork Cu, Utah | Cox and Theodore, 1986; Meinert and others, 2005 |
| Genetically related features | Deposit environment | Deposit group | Deposit type | Synonym(s) | Example(s) | Reference(s) |
|----------------------------|---------------------|---------------|--------------|------------|------------|--------------|
| Occurs in more than one system type | Magmatic hydrothermal | Skarn | Skarn tungsten ± Mo | NA | AUS: Molyhil, NT; O’Calaghans, WA; CAN: Cantung, NT; MacTung, YT; Emerald Tungsten, Didger, Feeney, Invisiville, and Dimac, BC; RUS: Tynnyauz; U.S.: Pine Creek, Calif.; Tem Piute district, Nev. | Meinert and others, 2005 |
| Continental back arc or hinterland, S-type volcano-plutonic center, magmatic fluid, alkali and hydrolytic metasomatism | Magmatic hydrothermal | Skarn | Skarn tin ± copper ± Mo | NA | CAN: Silver Diamond, BC; Atlin Magnetite, BC; Daybreak, BC; JC, YT; U.S.: Lost River, Alaska; Majuba Hill, Nev. | Reed and Cox, 1986; Meinert and others, 2005 |
| Occurs in more than one system type | Magmatic hydrothermal | Skarn | Skarn gold ± copper ± tungsten | Intrusion-related gold | AUS: Red Dome, QLD; CAN: Banks Island, BC; Hedley, BC; Ketza River, Marn and Horn, YT; Nickel Plate, BC; French, BC; Canty, BC; Good Hope, BC; Quesnel River, BC; U.S.: Fortitude and McCoy, Nev. | Ewers and Sun, 1989; Sillitoe, 1991; Theodore and others, 1991; Hart and others, 2002; Meinert and others, 2005; Hart, 2007 |
| Occurs in more than one system type | Magmatic hydrothermal | Skarn | Skarn zinc-lead-silver | NA | CAN: Piedmont, BC; Midway, BC; Contact, BC; Quartz Lake, YT; U.S.: Groundhog, N. Mex. | Meinert and others, 1995b; Meinert and others, 2005 |
| Genetically related features | Deposit environment | Deposit group | Deposit type | Synonym(s) | Example(s) | Reference(s) |
|-----------------------------|--------------------|--------------|--------------|------------|------------|--------------|
| Occurs in more than one system type | Magmatic hydrothermal | Skarn | Skarn molybdenum | NA | CAN: Coxe, BC; Novelty, BC; U.S.: Little Boulder Creek, Idaho; Cannavan Gulch, Mont. | Ray, 1995; Meinitert and others, 2005 |
| Continental rift, hydrous bimodal magmatism, A-type volcano-plutonic center, magmatic fluid | Magmatic hydrothermal | Skarn | Skarn beryllium-fluorite | NA | U.S.: Iron Mtn., N. Mex. | Barton and Young, 2002; Meinitert and others, 2005 |
| Peralkaline volcano-plutonic center | Magmatic hydrothermal | Skarn | Skarn uranium-REE | NA | AUS: Mary Kathleen REE-U, QLD | Oliver and others, 1999; Meinitert and others, 2005 |
| Arc or rift, alkaline volcano-plutonic center, magmatic fluid, alkali and hydrolytic metasomatism | Magmatic hydrothermal | Porphyry | Porphyry copper ± gold | Alkaline porphyry copper | AUS: Cadia, NSW; Northparkes, NSW; CAN: Galore Creek, BC; Copper Mountain, BC; Afton-Ajax, BC | Seedorff and others, 2005; Sillitoe, 2010 |
| Arc, magnetite series, calcalkaline volcano-plutonic center, magmatic fluid, alkali and hydrolytic metasomatism | Magmatic hydrothermal | Porphyry | Porphyry copper-molybdenum | Calc-alkaline porphyry copper | CAN: Highland Valley, BC; Gibraltar, BC; Brenda, BC; Highmont, BC; U.S.: Butte, Mont.; Bingham Canyon, Utah | Seedorff and others, 2005; Sillitoe, 2010 |
| Continental back arc or hinterland, felsic magmatism of ilmenite to magnetite series, calc-alkaline volcano-plutonic center, magmatic fluid, alkali and hydrolytic metasomatism | Magmatic hydrothermal | Porphyry | Porphyry gold ± copper | Intrusion-related gold | AUS: Mungana, QLD; CAN: Kerr, BC; U.S.: Palmetto, Nev. | Hollister, 1992; Nethery and Barr, 1998; Seedorff and others, 2005 |
Table 2. Deposit classification scheme.—Continued

| Genetically related features | Deposit environment | Deposit group | Deposit type | Synonym(s) | Example(s) | Reference(s) |
|-----------------------------|---------------------|---------------|--------------|------------|------------|--------------|
| Continental rift, hydrous bimodal magmatism, A-type volcano-plutonic center, magmatic fluid | Magmatic hydrothermal | Porphyry | Climax-type porphyry molybdenum | AUS: Unicorn, VIC; U.S.: Climax and Henderson, Colo. | Seedorff and others, 2005; Ludington and Plumlee, 2009; Audétat and Li, 2017 |
| Arc, magnetite series, calc-alkaline volcano-plutonic center, magmatic fluid, alkali and hydrolytic metasomatism | Magmatic hydrothermal | Porphyry | Low-fluorine porphyry molybdenum | CAN: Endako, BC; MAX, BC; Boss Mountain, BC; U.S.: Pine Nut, Nev.; Thompson Creek, Idaho | Theodore, 1986; Sinclair, 1995a; Seedorff and others, 2005; Taylor and others, 2012 |
| Continental arc, back arc, or hinterland, felsic magmatism of ilmenite series, calc-alkaline volcano-plutonic center, magmatic fluid, alkali and hydrolytic metasomatism | Magmatic hydrothermal | Porphyry | Porphyry tin | NA | CAN: Mount Pleasant, NB | Sinclair, 1995b; Seedorff and others, 2005 |
| Continental back arc, or hinterland, felsic S-type volcano-plutonic center, magmatic fluid, alkali and hydrolytic metasomatism | Magmatic hydrothermal | Porphyry | Porphyry tin | NA | CAN: Mount Pleasant, NB; U.S.: Majuba Hill, Nev. | Reed, 1986b; Sinclair, 1995c; Seedorff and others, 2005 |
| Continental back arc or hinterland, felsic S-type volcano-plutonic center, magmatic fluid, alkali and hydrolytic metasomatism | Magmatic-Magmatic hydrothermal | Greisen | Greisen tin ± W-Mo | NA | AUS: Anchor, TAS; CAN: Kemptville, NS; RUS: Spokoininskoye; SAU: Silsilah Sn | Reed, 1986d |
Table 2. Deposit classification scheme.—Continued

| Genetically related features | Deposit environment | Deposit group | Deposit type | Synonym(s) | Example(s) | Reference(s) |
|-----------------------------|---------------------|--------------|--------------|------------|------------|--------------|
| Continental back arc or hinterland, felsic magmatism of ilmenite series, felsic calc-alkaline volcano-plutonic center, magmatic fluid, alkali and hydrolytic metasomatism | Magmatic hydrothermal | Greisen | Greisen tungsten-molybdenum ±Bi | NA | AUS: Wolfram Camp, QLD; CAN: Sisson, NB; Mount Pleasant, NB; KAZ: Akchatau; U.S.: Indian Springs, Nev. | Kotlyar and others, 1995 |
| Continental rift, hydrous bimodal magmatism, A-type volcano-plutonic center, magmatic fluid | Magmatic hydrothermal | Greisen | Greisen beryllium ±Li | NA | U.S.: McCulloughs Butte, Nev. | Barton and Young, 2002 |
| Continental back arc or hinterland, regional felsic magmatism of ilmenite series, calc-alkaline volcano-plutonic center, magmatic fluid, alkali and hydrolytic metasomatism | Magmatic hydrothermal | Intrusion-related | Reduced intrusion-related gold | Plutonic-related gold: intrusion-centered gold; sheeted vein gold; shear-related gold veins | CAN: Tombstone, YT; U.S.: Fort Knox, Alaska; Bald Mountain, Nev. | Sillitoe, 1991; McCoy and others, 1997; Thompson and others, 1999; Hart and others, 2002; Hart, 2007; Nutt and Hofstra, 2007 |
| Continental back arc or hinterland, regional felsic magmatism of ilmenite to magnetite series, calc-alkaline volcano-plutonic center, magmatic fluid, alkali and hydrolytic metasomatism | Magmatic hydrothermal | Intrusion-related | Oxidized intrusion-related gold | Plutonic-related gold; disseminated gold; plutonic gold; intrusion-related gold veins | AUS: Ravenswood, QLD; Timbarra, NSW; Dargues Reef, NSW; CAN: Côte, ON, Malartic, QB | Sillitoe, 1991; Mustard, 2001; Blevin, 2004; Helt and others, 2014 |
Table 2. Deposit classification scheme.—Continued

| Genetically related features                  | Deposit environment | Deposit group | Deposit type      | Synonym(s) | Example(s)                          | Reference(s)                                      |
|----------------------------------------------|---------------------|---------------|-------------------|------------|-------------------------------------|---------------------------------------------------|
| Anatexis or any felsic pluton                | Magmatic            | Pegmatite     | Simple pegmatite  | NA         | CAN: Buckingham, QC                  | Černý and Ercit, 2005; Martin and De Vito, 2005; London, 2008, 2016 |
| Continental back arc or hinterland, S-type plutonic center | Magmatic            | Pegmatite     | LCT pegmatite     | NA         | AUS: Greenbush, WA; Wodgina, WA; Pilangoora, WA; CAN: Tanco, MB; US: King Lithia, So. Dak. | Černý and Ercit, 2005; Martin and De Vito, 2005; London, 2008, 2016 |
| Continental rift, hydrous bimodal magmatism, A-type plutonic center | Magmatic            | Pegmatite     | NYF pegmatite     | NA         | CAN: Bancroft, ON; Little Nahanni, YT | Černý and Ercit, 2005; Martin and De Vito, 2005; London, 2008, 2016 |
| Anatexis associated with high grade metamorphism | Magmatic            | Pegmatite     | Abyssal pegmatite | NA         | CAN: Fraser Lakes, SK                | London, 2008                                        |
| SCLM partial melt, alkalic-peralkaline magmatic center, carbonatites | Magmatic            | Carbonatite   | Carbonatite REE   | NA         | AUS: Mt. Weld, WA; CAN: Wicheeda Lake, BC; Nisikatch Lake, SK; Montviel, QC; Lac Shortt, QC; Saint Honoré, QC; China: Bayar'obo; U.S.: Mountain Pass, Calif. | Verplanck and others, 2014, 2016; Simandl and Paradis, 2018 |
| SCLM partial melt, alkalic-peralkaline magmatic center, carbonatites | Magmatic            | Carbonatite   | Carbonatite niobium | NA         | CAN: Eldor, QC; Niobec, QC; Aley, BC; Blue River, BC; St. Lawrence Columbian Mine, QC | Verplanck and others, 2014, 2016; Simandl and Paradis, 2018 |
Table 2. Deposit classification scheme.—Continued

[ACT, Australian Capital Territory; Ag, silver; Al, aluminum; Ala., Alabama; Ariz., Arizona; As, arsenic; Au, gold; AUS, Australia; AZE, Azerbaijan; B, boron; BC, British Columbia; Be, beryllium; BHT, Broken Hill type; Bi, bismuth; BOL, Bolivia; BRA, Brazil; Ca, calcium; Calif., California; CAN, Canada; CD, clastic-dominated; CHL, Chile; CHN, China; Co, cobalt; CO₂, carbon dioxide; COD, Democratic Republic of the Congo; Colo., Colorado; Cr, chromium; CRI, Costa Rica; Cu, copper; CUB, Cuba; DEU, Germany; EEZ, Exclusive Economic Zone; ESP, Spain; EU, European Union; Fe, iron; FI, Fiji; FIN, Finland; Fl., Formation; GBR, United Kingdom of Great Britain and Northern Ireland; HFSE, high field strength elements; Hg, mercury; HS, high sulfidation; H₂S, hydrogen sulfide; Ill., Illinois; IND, India; IOA, iron oxide-apatite; IOC-G, iron oxide-copper-gold; IRE, Ireland; IS, intermediate sulfidation; ISCG, iron sulfide-copper-gold; ITA, Italy; JPN, Japan; K, potassium; Ky., Kentucky; LCT, lithium-cesium-tantalum; Li, lithium; LIP, large igneous province; LS, low sulfidation; MB, Manitoba; MEX, Mexico; Mg, magnesium; Mich., Michigan; Minn., Minnesota; Mn, manganese; MNG, Mongolia; Mo, molybdenum; Mo., Missouri; Mont., Montana; MRT, Mauritania; MT, magnetotelluric; MVT, Mississippi Valley type; Na, sodium; NA, not applicable; Nb, niobium; NB, New Brunswick; N. Dak., North Dakota; Nev., Nevada; NGA, Nigeria; Ni, nickel; N.J., New Jersey; NL, Newfoundland and Labrador; N. Mex., New Mexico; NS, Nova Scotia; NSW, New South Wales; NT, Northern Territory in AUS and Northwest Territories in CAN; NU, Nunavut; N.Y., New York; NYF, niobium-yttrium-fluorine; Okla., Oklahoma; ON, Ontario; Ore., Oregon; P, lead; PER, Peru; PGE, platinum group elements; PHI, Philippines; PNG, Papua New Guinea; QC, Quebec; QLD, Queensland; REE, rare earth elements; RUS, Russia; SA, South Australia; SAU, Saudi Arabia; SCLM, subcontinental lithospheric mantle; S. Dak., South Dakota; SEDEX, sedimentary exhalative; SK, Saskatchewan; SMS, seafloor massive sulfide; Sn, tin; So. Am., South America; SWE, Sweden; Ta, tantalum; TAS, Tasmania; Te, tellurium; Tenn., Tennessee; Tex., Texas; Th, thorium; Ti, titanium; TUR, Turkey; U, uranium; UKR, Ukraine; U-M, ultramafic and (or) mafic; U.S., United States; V, vanadium; VAMS, volcanic-associated massive sulfide; VEN, Venezuela; VMS, volcanic-hosted massive sulfide; VIC, Victoria; W, tungsten; WA, Western Australia; Wash., Washington; W. Va., West Virginia; Wyo., Wyoming; YT, Yukon Territory; ZAF, South Africa; Za, zinc; ZWE, Zimbabwe]

| Genetically related features | Deposit environment | Deposit group | Deposit type | Synonym(s) | Example(s) | Reference(s) |
|----------------------------|---------------------|--------------|-------------|------------|------------|--------------|
| SCLM partial melt, alkalic-peralkaline magmatic center and related pegmatites | Magmatic | Peralkaline igneous | Peralkaline igneous HFSE-REE | NA | AUS: Dubbo, NSW; CAN: Strange Lake, QC; Misery Lake, QC; Kipawa, QC; Thor Lake, NT | Dostal, 2016 |
| Zoned alkalic plutonic center | Magmatic | Apatite-nepheline-titanite intrusion | Apatite-nepheline-titanite intrusion | Alkaline massif, nepheline-syenite-foyaite complex | RUS: Apatyty | Kalashnikov and others, 2016 |
| Alkalic dike complex | Magmatic | Apatite intrusion | Apatite intrusion REE | Apatite vein | AUS: Nolans Bore, NT | Hussey and Dean, 2013; Huston and others, 2016a |
| SCLM partial melt, diatreme, kimberlite | Magmatic | Kimberlite | Kimberlite diamond | NA | AUS: Argyll, WA; CAN: Ekati, Gahcho Kue, Snap Lake, and Diavik, NT; Renard, QC; Victor, ON | Michalski and Modreski, 1991; Pell, 1999 |
| Archean to early Proterozoic continental rift or plume, high degree mantle melts, greenstone belts, ultramafic-mafic volcanic center | Magmatic | Komatiite | Komatiite nickel-copper-PGE | Kambalda-type, raglan-type | AUS: Kambalda; CAN: Langmuir, ON; Alexo-Dundonald, ON; Raglan, QC; Thompson, MB; ZWE: Damba | Page, 1986b; Naldrett, 2004; Zientek and others, 2017 |
| Continental rift or plume, high degree mantle melts, LIP, ultramafic-mafic layered intrusion | Magmatic | Ultramafic and (or) mafic-layered intrusion | U-M layered intrusion chroomium | NA | AUS: Coobina, WA; CAN: Bird River; MB; Ring of Fire, ON; ZAF: Bushveld Complex | Schulte and others, 2012 |
| Genetically related features                                                                 | Deposit environment                                      | Deposit group                                                                 | Deposit type                                                                 | Synonym(s)                                                                 | Example(s)                                                                 | Reference(s)                                                                 |
|---------------------------------------------------------------------------------------------|----------------------------------------------------------|-------------------------------------------------------------------------------|------------------------------------------------------------------------------|--------------------------------------------------------------------------------|--------------------------------------------------------------------------------|--------------------------------------------------------------------------------|
| Continental rift or plume, high degree mantle melts, LIP, ultramafic-mafic layered intrusion| Magmatic                                                  | Ultramafic and (or) mafic-layered intrusion                                   | U-M layered intrusion nickel-copper-PGE                                      | Contact-type                                                                | AUS: Savannah, WA; Radio Hill, WA; CAN: Muskox, NU; Crystal Lake, ON; U.S.: Maturi, Spruce Road, Minn. | Zientek and others, 2017                                                      |
| Continental rift or plume, high degree mantle melts, LIP, ultramafic-mafic layered intrusion| Magmatic                                                  | Ultramafic and (or) mafic-layered intrusion                                   | U-M layered intrusion PGE                                                     | Reef-type and (or) brecciated                                               | CAN: Lac des Îles, ON; Marathon, ON                                            | Zientek and others, 2017                                                      |
| Continental rift or plume, high degree mantle melts, LIP, ultramafic-mafic layered intrusion| Magmatic                                                  | Ultramafic and (or) mafic-layered intrusion                                   | U-M layered intrusion iron-titanium-vanadium                                | NA                                                                            | AUS: Balla Balla, WA; CAN: Grader, QC; Lac Doré, QC; Iron-T, QC; Sept Iles, QC; La Blanche, QC | Page, 1986a                                                                  |
| Continental rift or plume, high degree mantle melts, LIP, ultramafic mafic stock or pluton (maybe zoned) | Magmatic                                                  | Ultramafic and (or) mafic intrusion                                           | U-M intrusion nickel-copper-PGE                                                | NA                                                                            | CAN: Lynn Lake, MB                                                            | Naldrett, 2004                                                               |
| Continental rift or plume, high degree mantle melts, LIP, ultramafic-mafic sills, dikes, chonoliths | Magmatic                                                  | Ultramafic and (or) mafic conduit                                             | U-M conduit nickel-copper-PGE                                                 | Flood basalt Ni-Cu-PGE, ferropicroite Ni-Cu-PGE, picrite-tholeite N-Cu-PGE | AUS: Nebo-Babel, Expo-Savannah; CHN: Kalatongke; RUS: Norilsk; US: Eagle, Mich.; Tamarack, Minn. | Naldrett, 2004; Barnes and others, 2016; Zientek and others, 2017 |
| Obducted oceanic or back arc crust                                                           | Magmatic                                                  | Ophiolite                                                                     | Ophiolite chromite                                                           | Podiform chromite                                                            | CAN: Thetford Mines QC, Castle Mountain Nickel, BC; Scottie Creek, BC; PHL: Acoje   | Duke, 1995; Ash, 1996; Mosier and others, 2012 |
Table 2. Deposit classification scheme.—Continued

| Genetically related features | Deposit environment | Deposit group          | Deposit type                      | Synonym(s)                                      | Example(s) | Reference(s)                  |
|-----------------------------|---------------------|------------------------|-----------------------------------|-------------------------------------------------|------------|-------------------------------|
| Obducted oceanic or back arc crus. | Magmatic            | Ophiolite              | Ophiolite nickel-copper-PGE       | Picrite-tholeite Ni-Cu-PGE                       | PHL: Acoje | Yumul, 2001; Naldrett, 2004; Zientek and others, 2017 |
| Convergent margin, ultramafic-mafic magmatic center | Magmatic            | Ultramafic and (or) mafic intrusion | Arc-U-M intrusion titanium-vanadium | Alaskan-type, uraian-type                        | CAN: Lac Allard, QC | Page and Gray, 1986 |
| Convergent margin, ultramafic-mafic magmatic center | Magmatic            | Ultramafic and (or) mafic intrusion | Arc-U-M intrusion nickel-copper-PGE | Alaskan-type, uraian-type, picrite-tholeite Ni-Cu-PGE | CAN: Tulameen Complex, BC; Turnagain, BC | Page and Gray, 1986; Naldrett, 2004 |
| Convergent margin, late extension, intermediate plutonic center | Magmatic            | Anorthosite massif     | Anorthosite massif titanium        | Anorthosite plutox                              | CAN: Lac Doré, QC; Lac Tio, QC; Norway: Tellines | Woodruff and others, 2013 |
| Convergent margin, late extension, intermediate (= granitic) dikes, sills, chonoliths | Magmatic            | Anorthosite conduit    | Anorthosite conduit nickel-copper-PGE | Anorthosite-granite-troctolite Ni-Cu-PGE        | CAN: Voiseys Bay, NL | Naldrett, 2004; Barnes and others, 2016 |
| Meteorite impact, ultramafic-mafic magmatism | Magmatic            | Ultramafic and (or) mafic intrusion | Impact-U-M intrusion nickel-copper-PGE | Impact melt Ni-Cu-PGE                           | CAN: Sudbury, ON | Keays and Lightfoot, 2004; Naldrett, 2004 |
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