CIM Mineral Exploration Best Practice Guidelines

Prepared by the

CIM Mineral Resource and Mineral Reserve Committee

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A. Introduction

The CIM Mineral Exploration Best Practice Guidelines (the Exploration Guidelines) have been prepared to assist professional geoscientists and engineers to conduct consistently high-quality work in order to maintain public confidence. The Exploration Guidelines are meant to assist professional geoscientists and exploration practitioners in planning, supervising, and executing exploration programs. In Canada, there are generally two types of public resource reporting: "Disclosure", as defined by NI 43-101, is the reporting of technical information to the public and market participants for securities legislation purposes where a Qualified Person (QP) must be involved, and reporting of exploration information for governmental agencies to support obligations under laws including the Mining Acts of each of the Provinces and Territories. The Exploration Guidelines are also relevant where the results will not be publicly reported but are intended for internal company use.

While this document is intended as guidance for work conducted or supervised by geoscientists in Canada, many of the practices described herein can be adapted to mineral exploration activities in other countries.

The Exploration Guidelines are not intended to inhibit original thinking, or to prevent the application of new approaches that may develop into fundamental components of successful mineral exploration programs. Rather than provide prescriptive solutions to specific issues, they include general guidelines for current professional practice and to demonstrate and defend the merits of new methods. These guidelines do not preclude individuals and companies from developing more detailed guidelines specific to their own requirements.

The initial version of the Exploration Guidelines was prepared by the Canadian Institute of Mining and Metallurgy and Petroleum (CIM) Exploration Best Practices Committee and adopted by CIM Council on August 20, 2000.

On January 9, 2018, CIM Council formed a new committee, the Mineral Resources and Reserves Committee (CIM MRMR Committee) with a mandate to, among other things, update the Exploration Best Practice Guidelines. The mandate for the committee was accepted by CIM Council on March 2, 2018.

The new Exploration Guidelines document was adopted by the CIM Council on November 23, 2018.

B. Management and Execution of Exploration Projects

1. Project Management

For Canadian companies, and for holders of title to mineral properties in Canada, all exploration work must be designed and carried out under the supervision of at least one geoscientist. The geoscientist will be responsible and accountable for planning, executing, and interpreting all exploration activity carried out under his or her supervision and for implementing quality assurance programs and reporting.

The geoscientist should understand the managerial, logistical, and administrative aspects and responsibilities of the project. These include such areas as budgeting; scheduling; camp management, including supply chain and contractor management; health and safety regulations; security; and regulations governing health and safety, transportation and handling of dangerous goods, land use, harassment, indigenous rights, and anti-corruption measures.

a) Exploration Program Planning and Design

The geoscientist should ensure that the exploration program is based on a sound understanding of the regional-scale and property-scale geology, the target commodity, and the type and style of mineralization that is either known or being sought on the subject property. This understanding should be supported by relevant field data and should include a thorough review of available published, corporate, and private information. The geoscientist should design the exploration program and select the exploration methods and tools that will credibly test the geological premises and interpretation.

In planning, implementing, and supervising exploration work, the geoscientist should ensure that exploration practices are based on criteria that either are generally accepted in the industry, or can reasonably be justified on scientific grounds.

The geoscientist should periodically review the geological premises the exploration work is based on, and should update those premises as new field observations and data become available. The geoscientist should base this systematic and thorough review on all new information collected from the exploration program, describe and document the interpretation, and discuss any apparent inconsistencies in the data.

It is important to remember that the geoscientist is accountable for his or her practice, and this responsibility can never be delegated.

i. Previous Exploration Results

An initial step in designing an exploration program is to compile and review previous work that has been carried out on the property: geological mapping and sampling results, geophysical surveys, geochemical surveys, or drilling programs. The geoscientist can use either public domain information, including government geological survey programs and provincial assessment files, or information in a company's internal database and other sources. The geoscientist should validate the accuracy and verify the suitability of the information collected from previous work before using it. Data verification is a key concept and is different from data validation.

Data validation in an analogue format or a digital database includes all the checks done to make sure there are no errors or mismatches in the data (e.g., overlapping samples, mislabeling of data, mixed units, etc.). It is an important task, but it does not include verification of the underlying data.

Data verification is related to the integrity and accuracy of the data to represent results that are reasonable. All data that are to be included in a project database should be checked. This includes "legacy" data of any type: geochemical, geophysical, drilling, sampling, metallurgical, etc. from previous operators or government agencies. This information could be valuable to the project and should be verified for its integrity to confirm its degree of quality before being included in the project database. In other words, the current operator must audit the legacy data in order to accept responsibility for its use. Depending on the exploration stage, this may include independent sampling of surface showings or important soil anomalies, re-sampling of trenches or drill holes, twinning of holes, etc. These verification activities should be thoroughly described and documented.

ii. Legend

A standard geological legend, encompassing all major lithological units and including a list of geological symbols should be prepared and applied in a consistent manner for all exploration and drilling programs carried out on the subject property.

iii. Data Sets

A single set of geoscience data is often insufficient to understand the potential of an exploration property. A data set can be perceived as a layer of information, and each layer must be integrated to conduct a comprehensive analysis, form an opinion, and support the conclusions. Several types of surveys are typically compiled when evaluating the exploration potential of a property and selecting exploration targets.

iv. Coordinate System

An exploration program needs a consistent spatial coordinate system from the outset, to locate all exploration information on a property. Typical grid coordinate systems in use are local grids aligned to a specific feature on a property or grids tied to astronomic or Universal Transverse Mercator north. In many cases, the grid coordinate systems in Canada incorporate the International System of Units (SI), however, historical grid coordinate systems that incorporate the imperial system of measurement also remain in use.

Where surveys by previous owners used a grid coordinate system different from the current grid coordinate system, the location information for the survey must be converted to the current grid coordinate system before physical work begins. For best results, determine the grid coordinates on common points or survey stations that are physically present on the property for each grid coordinate system: examples of such common points could include drill hole casings or specific geographical features. Transposing other recorded locations from old to new grids can then be done arithmetically.

For discovery stage properties, permanent markers should be established as reference points for the property's grid coordinate system, for example by inscribing benchmarks and cut-crosses in permanent features such as a rock outcrop. On establishing permanent markers, make detailed and thorough descriptions of the methods and procedures to mark and locate them.

b) Tenure and Access

The geoscientist should confirm with his or her supervisors or the client, that tenure and access rights to the subject property have been secured before beginning work. Access includes permissions from, and agreements with, indigenous and local communities, land owners, and surface rights holders. The geoscientist should confirm the location of property boundaries, especially to properly locate significant exploration activities such as drilling.

c) Permits

The geoscientist should confirm with his or her supervisors or the client, that the project holds all necessary permits and permissions before beginning work. Many exploration activities that require the use of water from surface or groundwater sources or require extended stays on undeveloped lands require notification and permitting. The geoscientist should be fully aware of the permitting requirements to work in an area well before activities start. Obtaining permits often requires a component of community consultation, which should not be viewed as the only opportunity to meet with the affected communities and their members.

d) Corporate Social Responsibility

The exploration geoscientist is often the first person on a project to meet members of the local community. Before the first visit to the exploration area, the approach to community consultation should be considered. A geoscientist without personal experience in the area should seek advice from community consultation experts who do have it. Property holders, company management, the exploration team, and community consultation experts should identify, agree on, and document which of them has responsibility for each element of community relations.

As a basic principle of community engagement, start the consultation process early in the project or even well before the project begins. As the process aims at building relationships and trust through mutual understanding, meetings and events early in the project are often key components in ensuring success. The geoscientist should be prepared to attend meetings and events at community-selected venues. This shows respect and willingness to spend company time travelling to meetings and not always expecting community members to come to company offices.

Additional guidance for the execution of exploration programs is provided in the Prospectors and Developers Association of Canada e3 Plus documents (2014).

2. Records and Documentation

Storing geological, geophysical, and geochemical information in a standard digital format on a reliable medium makes it possible to compile and analyze data efficiently on computers. Paper records form a valuable backup and supplement. Guidance for standardization of digital data formats has been proposed by the Prospectors and Developers Association of Canada (2017). An additional example of standardization of digital data formats can be found in the guidelines of the Australian Government Geoscience Information Committee (2017).

3. Geological Surveys

Geological mapping programs observe and record information on major lithological units, alteration, structural features, and mineralization types present on or around an exploration property, along with the nature and location of major physiographical features. This information is typically compiled in a geological map, whose scale depends on the objectives defined at the design stage of the program. The information is collected and stored on paper and/or in digital format. At regional and local scales, maps show the location of major lithologies, structures, and alteration types, plus any potentially significant economic mineralization. Detailed geological maps typically display the lithology, alteration, and structural features of a small area such as an exploration trench or an individual outcrop.

Samples collected during the course of a geological mapping program are used to:

- accurately determine lithology;
- determine the mineral or metal content of geological features of interest;
- determine the chemical composition of a given rock unit or alteration type.

The locations of these samples must either be recorded on a geological map or provided as a separate record such as a field note book. The sites of all field samples should be clearly marked so the sample site can be re-visited when necessary.

The project should retain a suite of hand samples that display representative characteristics of the host rocks, alteration styles, and mineralization types found on the property for reference and training. Preparation of this suite ensures that geological mapping information is collected in a consistent manner by all members of the exploration team.

For all data collection there should be documentation related to equipment type and methodology; calibration methods, frequency, and dates. Records of relevant (digital) photos should also be maintained with the photos, including date, scale, and locations.

Information from other sources should be verified and the process of data verification, including the recording and tracking of data sources, should be thoroughly documented.

More detailed guidance on procedures for preparing geological maps and collecting and curating field samples can be found in textbooks or geological mapping manuals used by government geological surveys or by university and college Earth Science Departments. They can be obtained in short courses offered by industry associations, or from public-domain sources.

4. Geophysical Surveys

Geophysical exploration methods detect mineral deposits by measuring physical properties that differ significantly between a mineral deposit and the adjacent rock formations. Historically, geophysical exploration methods have used the principal physical properties of density (gravity), magnetic susceptibility, conductivity, chargeability, resistivity, radioactivity, and seismic velocity. In many cases the desired deposit or mineralized target has a physical property (or properties) that permits direct detection. In other cases, mineral deposits can be detected by virtue of the physical properties of an associated non-economic mineral or by association with a specific rock or alteration type.

Geophysical surveys can often provide critical information to support regional mapping and mineral exploration modelling. A brief discussion of physical and chemical properties of ore, ore-associated minerals, the geophysical methods used, and characteristic signatures for selected mineral deposit types are presented in Ford et al. (2007).

Geophysical surveys can be conducted on the ground surface or above the ground surface using aircraft. Geophysical surveys can also be carried out inside the bored-out cavities of exploration drill holes. These surveys can be conducted either by employees of a mining or exploration company or by companies that provide these services on contract. A detailed discussion of such items as the survey specifications, data acquisition procedures, data quality, data processing methods, data presentation methods, data storage formats, and safety considerations for geophysical surveys is beyond the scope of the Exploration Guidelines.

When developing and designing a geophysical survey, the geoscientist needs a clear understanding of the geophysical characteristics of the type of mineralization the program seeks and its possible location and orientation. This understanding must govern the choice of geophysical survey method and the design of the survey specifications. A qualified geophysicist should plan, supervise, and interpret the geophysical survey. An example of the design, quality assurance, and data dissemination for an aeromagnetic survey is presented in Coyle et al. (2014).

For all data collection but especially for geophysical, geochemical and drilling data, there should be documentation related to equipment type and methodology, calibration method and frequency, and dates. When dealing with geophysical surveys the documentation should include all items such as spacing, size, volume, weight, etc. – any parameter that when varied could influence or change the outputs.

5. Geochemical Surveys

Geochemical surveys have aided the search for new mineral deposits for many decades. These surveys have been used to search for many deposit types, and in varied terrains: glaciated and non-glaciated, permafrost, tropical, sub-tropical, and arid. The surveys can be carried out at a regional scale where the objective is to evaluate large areas for their potential to host a target mineral deposit, or at a property scale to find potentially economic mineralization. Surveys could sample lake sediments, stream sediments, soils, parent overburden, vegetation, groundwater, surface water, individual minerals, or weathered or fresh bedrock. The objective of these surveys is to find concentrations of one or more elements sufficiently above the regional or local background values to be considered anomalous.

Regional-scale surveys can be carried out by mining companies or their contractors, or by government geological surveys. While the results of regional-scale geochemical surveys carried out by mining companies may not be available to the public domain in all jurisdictions, the results of regional-scale surveys completed by a government geological survey are publicly available and typically contain a detailed description of the field procedures, sample preparation protocols, analytical methods used, quality assurance/quality control (QA/QC) protocols employed and results, and data processing and management procedures.

Property-scale geochemical surveys are carried out to aid in the discovery of a mineral deposit. The person performing the survey needs a clear understanding of the target mineral deposit model and its anticipated size to design and execute a property-scale geochemical survey. The survey should be guided by a good-quality, up to date topographic base map displaying all relevant information such as major cultural features, disturbed areas, and a compilation of all available geological and geophysical results.

Understanding the different survey methodology options, including their limitations, is important for choosing an appropriate sample medium, sample spacing, preparation protocol, and analytical method. A useful approach at this early stage is to conduct an orientation survey over an area of known mineralization in a similar area and under conditions similar to those anticipated in the target survey area. The goal of an orientation survey is to test different media and methodologies in order to identify which set of survey parameters offers the highest probability of detecting the target mineralization type under the conditions present in the proposed search area.

For a property-scale geochemical survey, successful operation demands collecting a consistent and appropriate sample medium, accurately determining sample depths and locations, preparing good field notes, consistently applying sample preparation protocols, and implementing a quality assurance and quality control (QA/QC) program. Designing and executing a QA/QC program for property-scale geochemical surveys often faces such challenges as sourcing appropriate media for use as sample blanks or certified reference materials and collection of field duplicates. The program design should include discussions with a qualified geochemist to plan, supervise, and interpret geochemical surveys.

As a geochemical survey can generate large volumes of information, the geoscientist must design proper data management systems to collect, store, and evaluate the results of these surveys. The exploration program should also include preparation and retention of all metadata in relation to the field samples along with copies of all analytical certificates. These records should include documentation related to equipment type and methodology; calibration method and frequency, standards used and dates of analyses.

A detailed discussion of such items as the field procedures, sample preparation protocols, sample analysis methods, QA/QC protocols, and database management procedures for property-scale geochemical surveys for each deposit type is beyond the scope of the Exploration Guidelines. Examples of geochemical survey methods that have been carried out for selected deposit types in Canada have been presented in Franklin et al. (1991).

6. Drilling Programs

a) Planning Drill Holes

The drilling method should be appropriate to the lithologies and commodities being investigated, the objectives of the program, and local drilling conditions. The selected drill hole diameter should provide sufficient representative sample material for geological description, geotechnical characterization, analysis, and stored reference purposes. The surface location of drill holes should be determined using methods with levels of accuracy that are relevant for the stage of the property. Grid coordinates measured by chaining or by hand-held Global Positioning System (GPS) units may be sufficient for exploration-stage projects. At the post-discovery and deposit delineation stage, collar location should be determined using more precise and accurate survey methods.

The geoscientist and/or the geologists under their supervision are encouraged to prepare a working drill hole cross section showing at a minimum the expected target location for every hole drilled. The cross sections should be updated on a regular basis as the drilling program progresses.

Drill hole deviation surveys should be undertaken at regular intervals downhole using techniques and instrumentation suited to the hole size, angle and length of holes, and the magnetic nature of the host rocks. An orientation study that examines the accuracy of the drill hole deviation as a function of down-hole deviation measurement spacing carried out at the post-discovery stage is useful for determining the optimum spacing for down-hole deviation measurements.

b) Retained Drilling Samples

The program should retain and archive a representative fraction of the drill hole material for future reference. On exploration-stage properties, retaining drill hole material and unused sample material remaining from the assaying program is generally made a routine part of a drilling program. Any time material is not retained, the geoscientist should document the reason why it was not retained. When considering the long-term storage requirements of this material, the geoscientist should be aware of his or her responsibilities for such material which may differ by jurisdiction: the local mining statute may mandate preserving, disposing, or destroying cores or cuttings. In jurisdictions that do not regulate retention and storage of these materials, the geoscientist should still consider any potential future uses of the material.

When conducting drilling programs for discovery-stage properties, the geoscientist should consider the future requirements for metallurgical, geotechnical, and environmental testing and studies when establishing the procedures for retention and storage of drill hole material and the remaining sample fractions. The use of metal tags is recommended for identifying the drill hole, core box, and contained interval. A tag should be firmly affixed by a weather resistant means to the outside of each core box and at a consistent location inside the core box. Often, the correct choices made at this stage can result in significant savings of time and cost and be of great benefit at a future date.

For training and reference the project should retain a suite of drill core or chip samples that display the representative characteristics of the host rocks, alteration signatures, and mineralization styles relevant to the property. This suite will aid in ensuring that logging information is collected in a consistent manner by all members of the exploration team.

c) Logging Procedures

Logging of drill core or sample chips should be carried out by qualified and competent personnel that have both the proper training and sufficient experience. Logs require a description of the lithologies, alteration types and intensities, mineralization types and intensities, the type, quantity and distribution of potentially economic minerals or materials, structural types and intensities, hyperspectral data, and geotechnical information. Photographs of the drill core prior to splitting should also be taken as part of the logging process and stored for future reference.

The angles of intersection of given geological structures, measured relative to the axis of, or the perpendicular to, the drill core, are also recorded as part of the logging program. For deposits that are structurally controlled, oriented core provides better spatial description of structural features and improves the predictive values of models based on structural measurements.

d) Sample Intervals

The drill logs need to record the locations and lengths of samples taken for analysis. In the case of core drilling, sampled intervals should be marked in the core boxes by the logging geoscientist. The lengths of intervals of drill core taken for assays can vary in order to sample a specific geological feature, such as a vein or altered interval, or they can have a constant length. Sample intervals for reverse circulation and other rotary-type drill holes are typically a constant length. Sampled intervals respecting geological contacts have the benefit of providing an estimate of the potentially economically interesting materials or metals in the specific geological feature that is intersected. Should constant-length samples be used, the sample length should be chosen to match the anticipated nature of the target mineralization being sought. In the case of discovery-stage and deposit delineation stage properties, the geoscientist should consider the impacts of the sample collection strategy and sample lengths, as this information will form a critical and fundamental component in the preparation of Mineral Resource estimates.

For discovery-stage and delineation-stage properties, the geoscientist should design the sample selection protocols to ensure that a complete and uninterrupted series of samples are collected through the anticipated mineralized interval, along with a sufficient number of samples of unmineralized material on either side of the mineralized intervals. In general, individual samples should not overlap different lithologies or encompass sections with significantly different styles or concentrations of mineralization.

e) Bulk Density Measurements

For discovery-stage and delineation-stage properties, collection of bulk density information early in the exploration program, not only for the mineralized material, but also for the adjoining non-mineralized material, can save significant time. The bulk density of representative samples should be measured and recorded at appropriate intervals, using a method appropriate for the sample material. The choice of methods for determining the bulk density of a particular deposit is the responsibility of the geoscientist and will depend on the physical characteristics of the mineralization and the available sampling medium. Suitable QA/QC procedures should be established to monitor and correct for anomalous readings and maintain a high-quality data set. Lipton and Horton (2014) present further guidance on sample collection and preparation, and measurement of bulk density.

f) Drill Logs

The drill log format, whether on paper or digital, and the level of logging detail should be suited to the type of drilling, the site's geological conditions, and the nature of the mineralization. Logs should be appropriately detailed for:

- the type of drilling being conducted;
- the purpose or target of a particular drill hole;
- the geological setting;
- the type of mineralization;
- geotechnical conditions.

Core or sample recoveries should be noted on the logs. All geological information collected in drill hole logs should use a standard geological legend that is consistent with the geological information for the property. Any downhole geophysical information or other survey data related to the drill hole should also be kept with the drill log.

The choice of geological and logging software should ensure that all relevant exploration information can be captured in a consistent, functional, and secure manner that is suitable for use in subsequent phases of property evaluation. Results from drilling programs can be effectively recorded and stored in either physical format or spreadsheet format for early-stage exploration properties.

For discovery-stage and delineation-stage exploration properties, storage of drill hole data in a relational database that provides proper control and security is preferred to storage in spreadsheets. Spreadsheets cannot be secured as effectively as databases and, consequently are prone to an increased likelihood of errors during data manipulation. Considering the cost of fieldwork, drilling, and laboratory analysis, the cost related to proper data storage is justified to ensure the integrity and efficient use of project data.

The geoscientist should institute a database management protocol that includes a program of data verification to confirm that accurate and error-free information is entered into the drill hole database. The procedures and parameters used to prepare and execute drilling programs should be documented in a set of standard operating procedures to ensure that the programs are executed, and that the information is collected systematically. For all data collection there should be documentation related to equipment type and methodology, location, dates and personnel involved with the program.

g) Drill Sections

Project staff must develop cross sections, plan views, and longitudinal projections, in either digital or physical format, depicting basic geology and drill hole data and their correlation with surface geology and nearby drill holes. These should be updated as drill holes are completed. An archive, consisting of a copy of the final drill hole database and accompanied by a full set of sections and plan views, in paper or digital format, should be prepared at the end of each drilling phase and retained for future reference.

7. Sample Preparation, Analysis, Security, and QA/QC

All sampling programs should be carried out carefully and diligently, using scientifically established sampling practices designed and tested to ensure that the results are representative and reliable. A geoscientist should supervise the sample collection and ensure that a chain of custody of the samples is established and recorded.

The geoscientist supervising the preparation of samples for analysis should ensure that any work by employees, contractors, or consultants is done by trained, competent personnel and that appropriate QA/QC programs and security procedures are followed for analytical work. Whenever several persons carry out similar duties or when the data have been collected over a period of time, the geoscientist should use a system of checks and controls that ensures the quality and consistency of the data being produced.

a) Sample Preparation

The sample preparation procedures used in each mineral exploration program should be appropriate for the objectives of the program. Where the volume of individual field samples is reduced prior to shipping to a laboratory for analysis, unbiased splitting procedures to obtain representative subsamples should be tested, verified, and then applied.

Sample preparation procedures should be appropriate to the material being tested and the elements being analyzed. Representative fractions of the material sufficiently large to be analyzed or tested should be retained for a period of time, to be determined by the geoscientist, company policy, or regulatory requirement.

b) Sample Analysis

Analysis and testing of samples should be completed by a reputable and preferably ISO-accredited laboratory qualified for the particular element or material to be analyzed or tested. The geoscientist bears the responsibility of selecting the laboratory, testing, or mineral processing facility, and the analytical methods used. All analytical or other test results should be supported by duly signed certificates or reports issued by the laboratory or testing facility and should be accompanied by a statement of the methods used.

The sample digestion and analytical methods chosen must be properly documented and justified. If these are not standard procedures for the prospective minerals on the property, this should be disclosed in detail, including a discussion of the reasons for their use and evidence of their efficacy.

New methods and techniques of determining the quality, concentration, or quantity of mineralization or materials of interest are continually being developed. A geoscientist should be open to applying new techniques but should recognize that these approaches entail additional responsibilities. The geoscientist relying on analytical results obtained from a new analytical technique must be able to demonstrate the suitability of the technique to the task at hand and the reliability of the information.

The use of handheld X-ray fluorescence (XRF) analyzers to determine elemental concentrations in a sample is an example of a new method finding application in the exploration industry (Waldie and McCartney, 2010). Handheld XRF analyzers can be used to rapidly evaluate the concentration of certain elements in rocks, soils, drill cuttings, and cores. These units can help provide rapid information to field geologists, assist in recognizing new or unexpected types of mineralization, and enable on-the-spot decisions to extend or infill drill holes for an exploration-stage property. Occasionally, handheld XRF analyzers may provide significant and potentially material information about mineralization on a property; however, a geoscientist must clearly understand the strengths and shortcomings of this method, the proper conditions and procedures for use of the method in mineral exploration programs, and need to convey this information along with the analytical results to the users of the data. A review of the reliability and validity of portable XRF data has been provided by Gazley and Fisher (2014).

Most importantly, the geoscientist must understand his or her responsibilities in the collection and dissemination of information collected by any new analytical methods. In general terms, where specific guidance has not been provided on a topic, the geoscientist should rely on good scientific principles and conduct such as integrity of knowledge, objectivity, and transparency.

c) Sample Security

The security of samples from acquisition to analysis is a vital component of the sampling and analysis process. Procedures should include the use of secure core logging, sampling, storage and sample preparation facilities, and the prompt, secure, and direct shipping of samples to the laboratories. The geoscientist should put practical and reliable security procedures in place, given the deposit type, style of mineralization, and the logistical requirements of the project site.

d) Analytical Quality Assurance and Quality Control

Throughout the process of mineral exploration, the geoscientist should ensure that a quality assurance (QA) program is in place and that required quality control (QC) measures are implemented to confirm and document the accuracy and precision of results received from an analytical facility. QA programs should be systematic, apply to each drilling/sampling campaign, and to all types of analytical data, across the full range of values measured and not just high or unusual results. Discussion regarding QA/QC practices and procedures have been presented in Long (1998), Abzalov (2011), and Roden and Smith (2014). Audits of the methods and procedures used by the primary assay laboratory should be conducted on a periodic basis.

QA/QC programs appropriate to the type of sample and the mineralization should be planned and implemented as integral components of an exploration program. These programs should include submission of external blanks, certified reference materials, and duplicate samples, and regular check sampling by a third-party analytical laboratory. Blanks and certified reference material samples should be included in the sample set frequently enough to provide statistical confidence in the results.

Complete disclosure of QA/QC results from early-stage, discovery-stage, and delineation-stage exploration programs is recommended.

For analytical results, a program of data verification should also be in place to confirm the accuracy of the data entered into the analytical database. Suitable database management and backup protocols should be in place to ensure that the quality, integrity, and security of the database is maintained.

Analytical and QC data can be stored in a relational database that provides proper control and security as best practice: however, this data can also be stored in spreadsheet format.

Guidance regarding standardization of digital data formats has been proposed by the Prospectors and Developers Association of Canada (2017). An additional example regarding standardization of digital data formats can be found in the guidelines put forward by the Australian Government Geoscience Information Committee (2017).

8. Reporting Results from Mineral Exploration Programs

The results of a mineral exploration program should be professionally presented in a detailed report. These reports should be prepared following completion of each phase or stage of work.

The interpretation and assessment of results at the end of each phase of work should determine if the program objectives have been met and whether further work is justified. Any plan for further work should identify exploration targets, recommend an exploration program, and present a budget and schedule. Any changes in working hypotheses and objectives should be recorded.

In Canada, there are generally two types of public reporting:

1) "Disclosure", as defined by NI 43-101, is the reporting technical information to the public and market participants for securities legislation purposes where a Qualified Person (QP) must be involved. The rules for disclosure do not encompass public reporting filed with a government or agency related to obligations under laws and regulations other than securities legislation.

2) Reporting of exploration information for governmental agencies to support obligations under laws and regulations (others than securities legislation) including publicly available assessment reports required by provincial mining law, or environmental reports required by federal or provincial permitting processes. In these cases, non-QP professionals or even non-professionals in some jurisdictions (e.g., prospectors) can be responsible for this reporting. For holders of title to mineral properties within the boundaries of Canada, the geoscientist should be familiar with the reporting requirements prescribed by the Mining Acts of each of the Provinces and Territories.

For cases where the results of exploration programs are prepared for internal company use, the reports should contain, at a minimum, information on the following topics:

- Property Description and Location
- Accessibility, Climate, Local Resources, Infrastructure and Physiography
- Description of Previous Exploration Activities and Results
- Geological Setting and Mineralization
- Deposit Types
- Mineral Exploration Activities
- Drilling Results
- Sample Preparation, Analyses, Security, and Quality Assurance/Quality Control
- Data Verification
- Environmental Studies, Permitting, and Social or Community Impact
- Interpretation of Results
- Conclusions and Recommendations

C. Acknowledgements

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