PROFESSIONAL GEOSCIENTISTS ONTARIO

GENERAL PROFESSIONAL PRACTICE GUIDELINES FOR ECONOMIC GEOLOGISTS

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This guideline was developed by the PGO's Geology Subcommittee

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TABLE OF CONTENTS

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Summary of Key Points

- Professional geoscience services are required for a broad set of geological work. In Ontario, all work must follow the Code of Ethics of Professional Geoscientists, which includes respecting communities as well as health, safety, and the environment.

- A professional geoscientist shall comply with all applicable laws of any jurisdiction where work is performed or where a report or an opinion is provided on geoscientific matters.

- Within a project in Ontario, all elements requiring the practice of a Professional Geoscientist (P.Geo.) must be under the supervision of a P.Geo. (or multiple P.Geo.'s) possessing the required knowledge and qualification for each of the elements. The P.Geo. should ascertain their ability to assume responsibility for others' work while acting as a supervisor in the jurisdiction where the work is being performed.

- If a P. Geo. is practicing outside of Ontario, they must register to an appropriate Self-Regulating Organization (SRO) in the jurisdiction within which they plan to work.

- The P.Geo. can use plans, specifications, reports or documents another person has prepared if the P.Geo. has thoroughly reviewed and considers them valid and accepts professional responsibility for their use. Previous work must be based on sound science and proper documentation should be preserved.

- The P.Geo. will ensure that quality control procedures are in place and that documentation is present to support the results. Records must be kept for all work performed and must be prepared consistently by all personnel involved with the work.

- Data used for conclusions presented in geoscience work should be appropriately processed, presented, and explained with an understanding of the impact on the geoscience work.

- Ongoing review of the work should be done to allow for possible changes to the program and consistency of application of controls.

- When new methods or technology are introduced, the supervising P.Geo. should be able to understand and explain the effects of this new process on the work including any risk to the quality of the work, or the change in impact of the work on other aspects of the project such as safety or the environment.

- A report should be produced documenting the geological work completed and presented in an appropriate manner with all participating P.Geo.'s and their tasks documented.

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1. Introduction

These guidelines have been prepared by Professional Geoscientists Ontario (PGO) to assist Professional Geoscientists (i.e., the "P.Geo.") in the planning and supervision of all geology work related to exploration, mining, petroleum, economic or engineering geology as well as related geochemistry and geological modeling. These guidelines have also been prepared to assist Professional Engineers (P.Eng.) who are qualified to practice geoscience in accordance with the Professional Geoscientist's Act, 2000.

For the purposes of this guideline, geology work that requires professional geoscience can include, but is not limited to, activities such as, oil and gas exploration, mineral exploration and mining activities, mineral resource estimation and geological assessment for civil and geotechnical projects.

A P.Geo. is responsible and accountable for the planning, execution, and interpretation of all associated geology work as well as the implementation of quality assurance programs and reporting of work done under their supervision. Geology work that requires the practice of professional geoscience must be conducted under the supervision of a P.Geo. who will be responsible and accountable for the planning, execution and interpretation of all investigation activities as well as the implementation of quality control and quality assurance programs and reporting, and therefore should have the relevant training associated with their professional designation. These general practice guidelines have been developed to result in a consistent quality of work that will maintain public confidence and protect human health and safety and the natural environment with due regard for Ontario Regulation 69: Code of Ethics of Professional Geoscientists.

This set of broad guidelines or "best practices" in the present "Guideline" has been developed to ensure a consistently high quality of work that will maintain public confidence and assist securities regulators. The guideline is not intended to inhibit the original thinking or application of new approaches that are fundamental to successful geological work and/or exploration. It is intended to complement other existing guidelines.

2. Geological Concept

The geological premise on which the application of geoscience is conducted to meet its objectives, including the deposit type and a geological model used to predict and describe the setting and style sought (mineralization, structure, lithology, etc.) and should be supported by relevant field data and a reasoned scientific approach using current and peer-reviewed scientific methodology.

3. Environment, Safety and Community Relations

All geological work should be conducted in a safe, professional manner with due regard for the environment, health and safety of workers and others, the concerns of local communities and within regulatory requirements. An environmental evaluation of the implications of the work, including baseline studies as appropriate to the stage of the project should be carried out in accordance with applicable regulations and evolving best practices.

The P.Geo. should be aware of local and regional regulations regarding the work performed as part of a project and plan for safety controls and mitigation and rehabilitation strategies as required. Work involving surface disruptions such as excavation should be planned for to control erosion, slope stability and water. Boreholes should be designed for protection and isolation of the water tables and arresting of artesian water flow. Such mitigation strategies should be considered in both the present project's needs and objectives as well as in the longer-term project closure. Containment of emissions, either fluid or dust, and of spillages, such as fuel, should also be designed accordingly.

The onus of environmental and safety incident reporting is placed on the project proponent and the P.Geo. as supervisor may be required to assume the role of rapporteur. As such, the early design and regular practice of protective strategies is essential.

4. Quality Assurance/ Quality Control

Throughout the process of geoscience work, the P.Geo. should ensure that a quality assurance program is in place and that any required quality control measures are implemented. Quality assurance programs should be systematic and apply to all types of data acquisition across the full range of values measured and not only to high or unusual results. The P.Geo. should have the ability to understand and explain the results and take effective corrective action as required. When laboratory work is conducted, analysis and testing of samples should be done by an accredited laboratory qualified and certified for the elements or material to be analyzed or tested. Project-appropriate protocols for analysis using duplicates, blank and/or certified reference material (CRM) always need to be followed. If the P.Geo. is required to prepare reference materials or blanks, they should carefully document the process and the suitability of the medium relative to the analysis method and the actual material being assessed.

5. Methods & Data Collection

Geoscience field work is to be planned and implemented under the direct supervision of a P.Geo. Data should be properly recorded and documented at appropriate scales. All data points should be accurately located with respect to known reference points in an appropriate coordinate system acceptable to local regulations. The P.Geo. supervising this work should ensure that any work by employees, contractors or consultants is done by competent personnel and that appropriate quality assurance programs and security procedures are practiced. Whenever several persons carry out similar duties or when the data has been collected over a period of time, care should be taken to maintain the quality and consistency of the data being collected.

6. Data Security

The P.Geo. should endeavour to put in place the best security procedures practicable to secure data in a correct, redundant, and retrievable manner, given the geographic conditions and data transmissibility available and the logistical constraints of the site location.

7. Records and Data Verification

All processes including planning, mapping, sampling, sample preparation, sample security and analysis or testing methodology should be accompanied by detailed record keeping, setting out the procedures followed, the results obtained, and the abbreviations used. Processes used should be well documented and justifiable and regularly reviewed by the project team.

If paper records are being kept, a careful conversion to digital storage on a reliable medium is recommended in a standard format that is secure, backed up with a quality assurance program and is retrievable.

A program of data verification should be in place to confirm the validity of data that are entered into the database. A summary of records should be included in a periodic report produced and signed by the P.Geo.

8. Sampling

The practices and procedures used in each sampling program should be appropriate for the objectives of the program. All sampling programs should be carried out in a careful and diligent manner using industry established sampling practices that are current and also designed and tested to ensure that the results are representative and reliable. Samples should be collected under the direction of a P.Geo. Quality assurance and quality control programs appropriate to the type of sample and the mineralization or media should also be planned and implemented. A representative fraction of the material sampled (surface rock or particulate samples, drill core, chips, or overburden, or field concentrates) should be retained. If original material is not retained for materials sent for analysis, the P.Geo. should report and explain the reason for this decision.

Where the volume of individual samples is reduced prior to shipping to a laboratory for analysis, appropriate reduction procedures previously established to obtain representative subsamples should be applied and verified. The material not submitted to the lab should be retained for a reasonable and specified time for future audit of the results or retesting of the subset.

9. Drilling

When a drilling project is planned, the drilling or boring method will be recommended or approved by the P.Geo. and should be appropriate to the material being investigated, the objective of the program and local drilling conditions. The drill hole size selected should provide sufficient representative sample material for analysis and reference. Surface and downhole locational surveys should be undertaken using techniques appropriate for the hole size, angle, and length of holes. Drilling requires considerable surface preparation including the drill platform, access routes, water management and mitigation for fuel and other spills; these factors should be considered as part of the decision to select a drilling method.

10. Drill Core Sample Retention

The P.Geo. should ensure that a representative selection of drill core and other sampled media are retained for future work. Any time that material is not retained or is being discarded, the P.Geo. should document the reason for this decision. When considering disposal, the P.Geo. should consider any future work that could be done and give a reasoned recommendation to further retain samples. Where the sampled material results in a significant discovery to the geological record, such as a fossil, steps should be taken to protect the material from destruction by donation to the Ontario Ministry of Energy, Northern Development and Mines, Ontario Geological Survey, Royal Ontario Museum or other appropriate local institution.

When sampling drill core, every effort should be made to retain drill core by sawing or splitting the core in half and leaving one half in the box. Pre- and post-sampling photos are also recommended. There are situations when the full core may be sampled. Where sections of full core are sampled, pre-sampling photos are strongly encouraged and blocks inserted to replace

the core that is missing, and the box should be labelled to indicate a sample was taken. If the core is being marked for any reason, such as core orientation, consideration should be given to protecting these markings in the retained core by adjusting core sawing.
The P.Geo. should inform themselves of interpretations and rules regarding drill core storage. In some jurisdictions, drill core is an asset of the government and disposal requires permission. Storage of samples and/ or core can be expensive, so the P.Geo. should consider this as one of the long-term costs for a project.

11. Geological Logging

Geological logs, forms or software specifically suited to the type of drilling or other linear method such as trench and channel sampling, the particular geological situation and the minerals or media being sought, should be used for detailed geological descriptions. Similar logging methods that are compatible within a project should be planned and used for point samples such as soils or isolated rock samples. Logs should be appropriately detailed for the type of sampling method being used, the geological setting, type of mineralization or media and geotechnical conditions encountered. Core or other sample recoveries should be noted on the logs. Plans and cross-sections depicting basic geology and projections of sample data, including correlation with surface geology and any nearby sampling points should be developed and updated as mapping, surface sampling or drilling proceeds, and re-evaluated as time permits. Any downhole geophysical information or other such surveys should also be kept with the geological log. Similarly, surface survey information should be kept with the surface geological log data set. A photographic record of the core or of other recovered material is strongly recommended.

12. Geological Mapping

Geological mapping programs observe and collect geological information about a specific area or region. Information collected may include the mineralogy, granulometry, alteration, texture, structure, contacts, and so on. Geological maps may be captured either on paper or digitally or both and redundancy of this information should be assured. Field mapping should be supervised and when possible completed by a P. Geo. that has the proper expertise in the regional and local geological settings of the map area, and the ability and skills to collect the specific data required for the purpose of the mapping with instruments and techniques that are available and recognized through peer-reviewed processes. When mapping, the P.Geo. should ensure that the map includes a legend describing any symbols or abbreviations used, scale, direction, coordinates and if relevant, the direction the mapper is facing. It is advisable to take high-resolution photographs to complement the map. Maps must include the location of data collected as a punctual location or an area (e.g., X or outcrop contour) to allow the user to determine what part of the map is based on observations rather than interpretation. For wall mapping, photos are strongly recommended and should be taken perpendicular to the wall. Samples may also be collected and retained for further study and documentation. The samples

should be assigned a sample identification and survey coordinates should be documented. Storage of maps should follow the same rigorous program as any other dataset described in this guideline whether they are on paper or digitally created.

13. Sample Security

The security of samples from sample acquisition to analysis is a vital component of the sampling process. Procedures should include the use of secure core or media logging, sampling, storage and preparation facilities, as appropriate, and the prompt, secure and most direct shipping of samples to the laboratories and their subsequent storage, disposal or return from laboratory. The P.Geo. should endeavour to put in place the best security procedures practicable, given the geographic and topographic conditions and the logistics created by the site location.

The type of container or bag must be appropriate to the sample type and shut securely to prevent mixing or contamination and should resist opening or being otherwise damaged in transport. The use of waterproof sample identification (label, marker, etc.) is strongly recommended.

14. Sample Preparation

The selection of sample preparation procedures should be approved by the P.Geo. and should be appropriate to the material being tested, the elements being analyzed, and should be subject to the security measures as stated above. All samples that are reduced or split should be processed in a manner such that the fraction analyzed or tested is as representative of the whole sample as possible. Representative fractions of the material to be analyzed or tested should be retained for an appropriate period of time, as decided by the P.Geo. Quality control checks should be undertaken as determined by the P.Geo.

15. Analysis and Testing

Analysis and testing of samples should be done by a reputable and preferably accredited laboratory qualified for the particular material to be analyzed or tested. The selection of a laboratory, testing or mineral processing facility and the analytical methods used are the responsibility of the P.Geo. There are instances when a P.Eng. (metallurgy) will manage the laboratory, and during these times, the P. Geo. is expected to work in coordination with the P. Eng. to achieve the required quality controls.

The analytical methods chosen are of utmost importance and must be documented and justified. Appropriate documentation and/or experts should be consulted as required before analytical methods are chosen. All analytical or test results should be supported by duly signed certificates or technical reports issued by the laboratory or testing facility and should be accompanied by a statement of the methods used. The use of standards and blanks should be

incorporated in a manner to provide assurance of the process. The reliability of the analytical and testing results should be measured using the results of the quality control samples inserted in the process by the P.Geo. and a thorough review of the quality control sample results and laboratory procedures should also be performed for each batch. Duplicate analyses at other laboratories may be undertaken where appropriate.

Samples may be tested at certified laboratories for the specific analysis being requested or in-house assay labs. Certified laboratories are necessary where the assay results will be used for mineral estimation in resource and reserve calculations particularly if the operation is not a producing mine. In-house assay labs, such as a producing mine assay lab or exploration labs, may be used under the supervision of a P.Geo. It is essential for the P.Geo. to understand that they are responsible for the results of an in-house assay lab unless a certified assayer is on site and a regular external audit is not available. It is advisable that a quality assurance / quality control testing program be implemented to validate the in-house results with results from a certified laboratory.

16. Interpretation

An ongoing, comprehensive interpretation of all geological data is an essential activity at all stages of the project and should be undertaken to assess the results of the work. This interpretation should be based on all the information collected to date, and it should be systematic and thorough. The interpretation should describe, document, and discuss any information that appears to be inconsistent with the selected interpretation. The density of the geological data should be critically assessed as to its ability to support the qualitative and quantitative conclusions.

17. Recommendations

The interpretation and assessment of the project's results at the end of each phase should determine if the objectives have been met and if further work is justified. Any plan for further work or research should identify targets, recommend a program, and present a budget and schedule. Any changes in working hypotheses and objectives should be recorded on an ongoing basis and plans proposed to address this new information.

18. New Technology and Innovation

The P.Geo. is encouraged to integrate new technology or innovative techniques to advance the work and the project. The supervising P.Geo. should be able to understand and explain the effects on the new work procedures including any risk to the quality of the work, or the impact of the work on other aspects such as safety or the environment. In particular, the P.Geo. should consider areas where such innovation may be beneficial or could expose the project dataset to potential errors. If the new technology is to produce assay data to be used in project definition,

then it is imperative that the samples are tested not only by the new technology but also by one or more industry-accepted methods to verify that the new technology is accurate and effective. This will assist the P.Geo. in understanding the error and the applicability of the technology to the work.

Implementation of any new technology should follow a Change Management Plan. When introducing new technology, the supervising P.Geo. should conduct:

1. An initial risk assessment to identify and address the changing conditions or new risks to the quality of the resulting geoscience work.
2. A risk assessment during commissioning to identify and address any new risks to the integrity of the geoscience work.
3. A final assessment following implementation to monitor and address any new hazards to the quality of the geoscience work.

19. Geoscientists as Qualified Persons under Other Legislation

The P.Geo. should be mindful that their licensure in the Professional Geoscientists Ontario (PGO) or other self-regulatory organization is only part of the requirement for self-identification as a Qualified Person (QP) under federal or provincial legislation that regulate disclosure of geoscience work. The P.Geo. should also review requirements relevant to the specific geoscience activities being undertaken to ensure that they meet the required qualifications of various regulated definitions of Qualified Person(s).

The P.Geo. should also review requirements for years of relevant experience under the applicable legislation to ensure that they meet the required qualification. It should be noted that years of experience described below is not the same as the license requirements established by PGO for licensure.

National Instrument 43-101

This guide is not intended to replace or conflict with National Instrument 43-101 or its Companion Policy, Standards of Disclosure for Mineral Projects. The supervising P. Geo. who may be the QP for disclosure or transmittal of geoscience information or other mineral project disclosure should be aware of and adhere to the public reporting requirements set forth in NI 43-101 and its Companion Policy.

The P.Geo. considering identifying themselves as a QP should consider the self-declaration requirements as set out in NI 43-101 before taking on the responsibilities. The following is an excerpt from the Instrument in relation to Canadian P. Geos.

"qualified person" means an individual who

a) is an engineer or geoscientist with a university degree, or equivalent accreditation, in an area of geoscience, or engineering, relating to mineral exploration or mining;

b) has at least five years of experience in mineral exploration, mine development or operation or mineral project assessment, or any combination of these, that is relevant to his or her professional degree or area of practice;

c) has experience relevant to the subject matter of the mineral project and the technical report;

d) is in good standing with a professional association; and…

Ontario Environmental Protection Act, R.S.O. 1990, c. E.19 Act and Ontario Regulation 153/04 Records of Site Condition — Part XV.1

The Ontario Environmental Protection Act also defines a Qualified Person for the completion of Phase One and Phase Two Environmental Site Assessments and risk assessments for the purpose of filing a Record of Site Condition and O.Reg. 153/04, and includes numerous professional designations. The regulation does not specify experience beyond the licensure requirement. The P.Geo. is urged to seek guidance in respect of experience.

(2) A person meets the qualifications to be a qualified person for the purposes of subsection (1) if,

a) the person holds a licence, limited licence or temporary licence under the Professional Engineers Act;

b) the person holds a certificate of registration under the Professional Geoscientists Act, 2000 and is a practising member, temporary member or limited member of the Association of Professional Geoscientists of Ontario; …

Qualified Persons in other areas of geoscience

The P.Geo. should be mindful that other areas of geoscience may define QP requirements that are different than the ones quoted in this Guideline. The P.Geo. is advised to consult the other PGO Guidelines on Professional Practice for those definitions.

20. Conclusion

In summary, the P.Geo. should always maintain the highest standards of professionalism by adhering to Ontario's Code of Ethics of Professional Geoscientists, which includes respecting communities, seeking Zero Harm to health, safety, and the environment, and creating an inclusive workplace. The P.Geo. also needs to comply with all applicable laws of any jurisdiction where work is performed or where a report or an opinion is provided on geoscientific matters. The P.Geo. should strive to incorporate best practices wherever possible.

The following list (and links) of references is designed to help the P.Geo. in achieving and maintaining the high standards and best practices outlined in this document and is meant as a general list of references.

Professional Geoscientists of Ontario website https://www.pgo.ca/

Professional Geoscientists Act 2000 and Regulations https://www.pgo.ca/about/act-and-regulations

Canadian Institute of Mining, Metallurgy and Petroleum (CIMM) Standards, Best Practices website https://mrmr.cim.org/en/

43-101 - Standards of Disclosure for Mineral Projects https://www.osc.gov.on.ca/en/15019.htm

Ontario Legislation and Regulations website (e-laws) https://www.ontario.ca/laws

Ontario Ministry of Energy Northern Development and Mines https://www.mndm.gov.on.ca/en

Ontario Ministry of Natural Resources and Forestry https://www.ontario.ca/page/ministry-natural-resources-and-forestry

Ontario Ministry of Environment Conservation and Parks https://www.ontario.ca/page/ministry-environment-conservation-parks

The P.Geo. is encouraged to perform more detailed searches within each of the listed websites or other related websites.

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This guide was reviewed by the members of the PGO Professional Practice Committee and Council.