GRAVITY GRADIOMETRY FOR LUNAR SURFACE EXPLORATION. K. A. Carroll[1], [1]Gedex Inc., 407 Matheson Blvd. East, Mississauga, Ontario, Canada L4Z 2H2, kieran.carroll@gedex.ca .

Abstract: The first (Apollo) phase of Lunar surface exploration primarily employed geological surveying techniques (collecting rocks, taking photographs) to characterize the surface properties of the Moon near the landing sites. Future Lunar exploration will include activities which involve excavating the surface for various reasons, such as:

- Drilling to extract core samples.
- Collecting material for processing to extract resources such as oxygen.
- Digging pits into which crew modules can be emplaced which will provide thermal and radiation shielding.
- Collecting material for building berms to shield equipment and crew from rocks/dust entrained in the exhaust from landers.

It will be important to know the subsurface distribution of rock types and sizes within volumes of Lunar regolith that are being considered for such excavations, to avoid encountering rocks too large to excavate, or large enough/hard enough to damage excavation equipment. Geophysical surveying techniques may be used to collect this type of information.

One such well-know geophysical exploration technique uses a gravity gradiometer to measure one or more component of the tensor which characterizes the spatial gradient of gravitational force. Gedex is a Canadian leader in developing gravity gradiometers for terrestrial airborne surveying applications. This paper describes a concept for a gravity gradiometer suitable for mounting on a Lunar rover, suitable for collecting this type of information via geophysical traverses. This type of survey will also have considerable geoscientific value.

Introduction: Gedex is developing a next-generation airborne gravity gradiometer system, referred to as the High-Definition Airborne Gravity Gradiometer (HD-AGGTM), which is based on cryogenic, superconducting technology which has been able to achieve performance in the lab rather better than its in-flight performance goal of 1 E RMS sensitivity at a bandwidth of 1 Hz. Several terrestrial applications, relating to exploration for mineral and oil&gas deposits, have been identified for this system and are currently being pursued.

In addition, technology development at Gedex towards the goal of a miniaturized, non-cryogenic version of this instrument is underway. This instrument is intended to be suitable for a wider range of environments and applications, including in space. Several specific space-based applications are being studied. One of those is considered here: deployment of a gravity gradiometer on a Lunar exploration rover, for geophysical exploration purposes.

This paper begins with a synthesis of results from the fields of planetary geosciences, geophysical instrumentation and space engineering. An overview is provided of what is known of the structure of the Lunar near-sub-surface, problems and questions of interest regarding that, the history of Lunar gravity measurements from orbit and on the surface, and of gravity gradients and gravity gradiometers. Next, some general considerations are provided regarding the deployment of a gravity gradiometer on a Lunar rover, and some specific types of sub-surface targets are identified which this instrument should be effective in detecting and delineating. Finally, results are presented from a quantitative study of the gravitational specific force and gravity-gradient signals that would be generated by Lunar rocks of various compositions and sizes, embedded at a range of depths within the Lunar regolith. The main conclusion is that it appears technically feasible to deploy a gravity gradiometer on a Lunar rover whose sensitivity would be sufficient to discern quite fine structures below the surface.