Supergene gold transformation:

Secondary and nano-particulate gold

from northern Finland

Thesis submitted in accordance with the requirements of the University of Adelaide for an Honours Degree in Geology

Paige Sawley

November 2014

THE UNIVERSITY of ADELAIDE

SUPERGENE GOLD TRANSFORMATION: SECONDARY AND NANO-PARTICULATE GOLD FROM NORTHERN FINLAND

SUPERGENE GOLD TRANSFORMATION

ABSTRACT

The transformation of gold (Au) in many supergene environments is driven by (bio)geochemical processes. This study assesses the link between surface morphologies of Au grains and supergene transformation processes in arctic settings. Gold grains were collected from nine sites across two localities in northern Finland, *i.e.*, Ivalojoki and Lemmenjoki. Sites were chosen based on contrasting elevations and settings, from glacial till to alluvial. Gold grains were studied using field emission scanning electron microscopy (FEG-SEM), focused ion beam-scanning electron microscopy (FIB-SEM) coupled with Energy Dispersive X-ray Spectroscopy (EDXS), and electron microprobe analyses (EPMA). Gold grains from all sites displayed supergene transformation features, *i.e*., morphotypes indicative of Au and Ag dissolution, as well as Au aggregation. The latter included a variety of secondary Au morphotypes, such as nano-particles and μ-crystals, sheet-like Au and branched Au networks. Dissolution features on grains from high organic matter environments suggest fulvic and humic acids are important contributors in the transformation of Au. Secondary Au occurs as part of the polymorphic layer. In addition to the secondary Au, the polymorphic layer consists of active microbial biofilms, organic matter and biominerals suggestive of remnant biofilms, as well as aluminosilicates, iron-sulfides and oxides. Bacterial cells and putative fungal hyphae were closely associated with Au nano-particles, suggesting that Au biomineralisation is an important factor in the transformation of Au. In conclusion, surface morphologies of Au grains from Finland are the result of supergene (bio)geochemical transformations occurring in the arctic environment.

KEYWORDS

Gold, supergene, Finland, arctic, nano-particles, biofilm

TABLE OF CONTENTS

1. LIST OF FIGURES

2. LIST OF TABLES