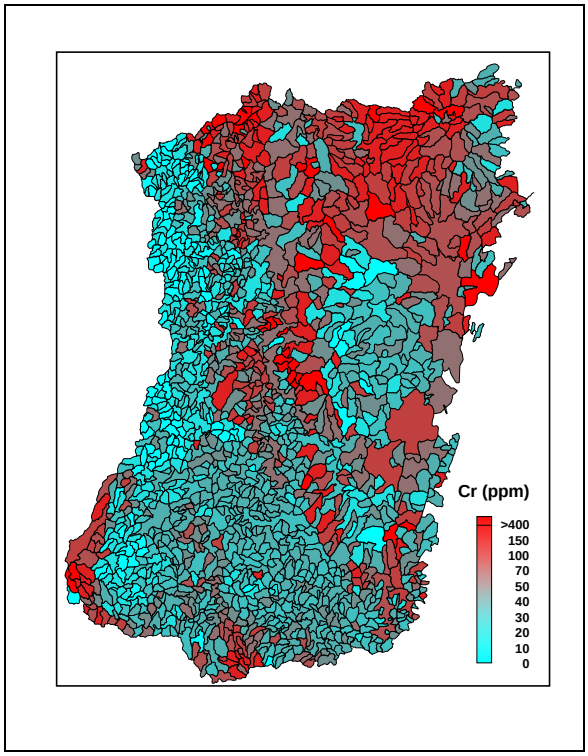
New Approaches to Detecting Geochemical Anomalies



A short course presented to the:

New South Wales
Department of Mineral Resources

By

Neil Rutherford
Rutherford Mineral Resource Consultants

David Cohen
School of Geology, University of NSW

Wednesday, 15 August 2001

RUTHERFORD
MINERAL RESOURCE CONSULTANTS
ABN: 60 396 553 906

UNSW
Geology

CONTENTS

1. INTRODUCTION

In many regions of the world, including Australia, large numbers of mineral deposits have been delineated using exploration geochemistry. A significant proportion of exploration expenditure since the 1960's has, therefore, been directed towards geochemical exploration, including regional reconnaissance programs, localised follow-up surveys and exploratory drilling. In deeply weathered terrains, exploration geochemistry has generally proved more successful in targeting mineralisation than exploration geophysics.

The objective of exploration geochemistry today remains unchanged - to delineate geochemical signatures related to mineralisation. However, the science of geochemistry is turning the corner. The gross oversimplification of past survey procedures and interpretive methods have often had a serious negative impact on the effective use of geochemical methods in exploration during the recent past. Current developments in areas as diverse as landscape evolution and analytical chemistry methods have prompted a review both the factors that generate anomalies and, hence, the definition of the term "anomaly" and the way in which we undertake and interpret exploration geochemistry. Utilisation of case histories and technological advances will demonstrate that the traditional “approved” approach practiced by many companies leaves “gaping holes” through which an ore body can quietly slip. These holes represent opportunities for mineral discovery at low cost for competitors who possess the skills to recognise the deficiencies or omissons of others, (Hoffman, S.J., 1989).

We have become used to prescribed or expected patterns of geochemical anomalism that fit into somewhat inadequate conceptual models of geochemical dispersion. Too often, if these prescribed patterns of “response” are not present, we walk away. Our apparent inability to routinely resolve subtle geochemical anomalism, such that might be expected from mineralisation in areas with cover or that is buried deeply, is largely due to the way in which we try to apply our outcrop geochemical experience in environments where there is no outcrop. It is no longer a world of log normal decay curves, means and standard deviations and big numbers, but one of noisy backgrounds, erratic distribution of geochemically variable transported lithotypes, structural leakage geochemistry, presence or absence of solute species irrespective of magnitude and values that push the lower limits of the analytical technology.

Although there are large tracts of relatively un-explored geological terrain in various parts of the world where routine geochemical sampling followed by simple basic interpretation will define mineralisation, it is much less likely the case in the more extensively explored terrains as in Australia, Europe or North America. In these “mature” terrains current exploration programs are being increasingly directed towards mineralisation with subtle or no surface expression. Here the application of geochemical techniques has had to evolve from recognising geochemical signatures of mineralization in leached outcrops and residual soils, towards identification of targets that are masked by transported cover or barren weathered zones. This requires more sophisticated geochemical models and methods, especially at the reconnaissance stage, with attention focussed on novel or refined approaches to sampling media, sample collection and processing, chemical analysis, data processing and data interpretation.

Recent advances, including the use of partial and selective extraction methods, vapour chemistry, groundwater and biogeochemistry, have proven capable of detecting weak dispersion haloes through deeply weathered and/or transported overburden. These advances have been linked to progressively better understanding of the processes and results of different styles of landscape evolution, regolith development and the transportation of metals.

A review of the chemical processes of weathering rock and sulphides and element mobility are given. Despite the extensive recent literature on the subject there is often a poor understanding of the basics of what is, in essence, a simple process complicated by erosional and depositional activity.

Strategies for implementing geochemical surveys, including data processing, integration and interpretation strategies, at both regional and follow-up scales will be considered with various case studies selected from within Australia and elsewhere. The course will demonstrate the potential of routine everyday geochemical methodology (with some adaptation to suit the geological, geophysical and geochemical environment of interest and different choices of analytical techniques) to resolve anomalism sourced from the small to the gigantic body of mineralisation.

The course material has been drawn from extensive personal experience and from published sources. Often the published sources and the personal experiences merge and cannot be separated, but hopefully most of the written sources have been cited in the Reference section. Several of the examples come from recent unpublished company exploration and the companies from which such data has been used are thanked.

Neil Rutherford

David Cohen

August, 2001