

# **21. Knowledge Gaps and Future Research Directions**

21 of 21

## **Volcanogenic Massive Sulfide Occurrence Model**

Scientific Investigations Report 2010–5070–C

**U.S. Department of the Interior**  
**U.S. Geological Survey**

**U.S. Department of the Interior**  
KEN SALAZAR, Secretary

**U.S. Geological Survey**  
Marcia K. McNutt, Director

U.S. Geological Survey, Reston, Virginia: 2012

For more information on the USGS—the Federal source for science about the Earth, its natural and living resources, natural hazards, and the environment, visit <http://www.usgs.gov> or call 1-888-ASK-USGS.

For an overview of USGS information products, including maps, imagery, and publications, visit <http://www.usgs.gov/pubprod>

To order this and other USGS information products, visit <http://store.usgs.gov>

Any use of trade, product, or firm names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Although this report is in the public domain, permission must be secured from the individual copyright owners to reproduce any copyrighted materials contained within this report.

Suggested citation:

2012, Knowledge gaps and future research directions in volcanogenic massive sulfide occurrence model:  
U.S. Geological Survey Scientific Investigations Report 2010-5070-C, chap. 21, 1 p.

# Contents

Supergiant Deposit Formation Processes .....	345
Mapping at Regional and Quadrangle Scales .....	345
New Modeling of Fluid Flow and Mineralization .....	345
Causes of Temporal and Spatial Localization and Preservation of Deposits .....	345
New Methods of Prospection for Concealed Deposits.....	345



# Chapter 21. Knowledge Gaps and Future Research Directions

This review of the state of knowledge of VMS deposits has revealed a number of areas that merit additional research. Following is a simple list of topics that deserve further attention.

## Supergiant Deposit Formation Processes

- Volumes of source rock or magma required for magmatic hydrothermal and lateral secretion models of metal sources;
- Geochemical discrimination of unique igneous ore-related magmas;
- Single fluid inclusion compositions in VMS ore minerals by new techniques to define metal concentrations during ore formation and to understand magmatic vapor rather than magmatic brine transport of metals; and
- Longevity of hydrothermal systems (need for improved geochronology).

## Mapping at Regional and Quadrangle Scales

- Relationships of heat and magmatic volatile producing igneous bodies to VMS deposits;
- Localization of mineralization—vertical and lateral;
- Post-ore plutons and gold rich VMS deposits;
- Ultramafic associations (komatiites); and
- Physical volcanology and facies architecture of volcanic belts.

## New Modeling of Fluid Flow and Mineralization

- New programs with new capabilities—HYDROTHERM, FISHERS, TOUGHREACT, GWB, GASWORKS;
- Duration and mass transport of hydrothermal systems;
- Reactive transport and solubility change due to dissolution/precipitation;
- Effect of magmatic volatile pulses into convective systems; and
- Fluid flow into hanging wall systems.

## Causes of Temporal and Spatial Localization and Preservation of Deposits

- Anoxia,
- Eruption,
- Landslides,
- Subseafloor mineralization, and
- Silica or mudstone/argillite caprock.

## New Methods of Prospection for Concealed Deposits

- Heavy minerals;
- Geochemistry, new isotope systems (Fe, Cu, Zn, <sup>33</sup>S), laser and ion microprobe analyses;
- Distal, cryptic alteration; and
- New geophysical techniques.

Publishing support provided by:  
Denver Publishing Service Center

For more information concerning this publication, contact:  
Center Director, USGS Central Mineral and Environmental Resources  
Science Center

Box 25046, Mail Stop 973  
Denver, CO 80225  
(303) 236-1562

Or visit the Central Mineral and Environmental Resources Science  
Center Web site at:  
<http://minerals.cr.usgs.gov/>

