

MISSISSIPPI VALLEY-TYPE (MVT) DEPOSITS

INTRODUCTION

- MISSISSIPPI VALEY TYPE DEPOSITS WERE FIRST DISCOVERED & DESCRIBED IN MISSISSIPPI, USA
- RANGE FROM 0.5 MT TO >20 MT OF CONTAINED ORE
- OWE THEIR ORIGIN TO FLUID CIRCULATION & METAL TRANSPORT/DEPOSITION WITHIN SEDIMENTARY BASINS (ARE OF HYDROTHERMAL ORIGIN)

- ARE **EPIGENETIC** & METALS CAN BE **DEPOSITED 10s OF MILLIONS OF YEARS AFTER SEDIMENT DEPOSITION**
- FORM FROM RELATIVELY LOW T (<150oC) **FLUIDS**
- BROADLY STRATABOUND & MAINLY **CARBONATE-HOSTED & TO A SMALL EXTENT SANDSTONE-HOSTED**
- MAIN SOURCE OF **LEAD & ZINC**; MVT CONTAIN A SIGNIFICANT PROPORTION OF WORLD'S Zn/Pb RESERVES

- CARBONATE-HOSTED ORES ARE CHARACTERISED BY **Pb>Zn>>Cu**
- MAJORITY OF MVT DEPOSITS ARE OF **DEVONIAN TO PERMIAN AGE** & TO A LESSER EXTENT CRATECEOUS TO PALEOGENE AGE
- THE FORMER ARE MORE IMPORTANT METALLOGENIC EPOCH WHICH COINCIDES WITH ASSEMBLY OF **PANGEA** WHEN **MAJOR COMPRESSIONAL OROGENIES WERE ACTIVE**

MINERALOGY

- MAJOR ORE MINERALS INCLUDE: **GALENA & SPHALERITE**
- **BARITE & FLUORITE** ARE ALSO IMPORTANT
- **PYRITE & MARCASITE** ARE WIDESPREAD
- **CHALCOPYRITE** IS A SIGNIFICANT SOURCE OF Cu
- MINOR SULPHIDES INCLUDE **BORNITE, COVELLITE, ENARGITE** ETC; OXIDES ARE **HEMATITE, CUPRITE** ETC; CARBOANATES INCLUDE **SMITHSONITE, CERRUSITE, MALACHITE**; SULPHATES ARE **ANGLESITE** ETC RESULT LARGELY FROM ALTERATION OF SULPHIDES
- GANGUE MINERALS INCLUDE **CALCITE, DOLOMITE, ARAGONITE, & QUARTZ**; **SIDERITE, ANKERITE & COLLOFORM SILICA** MAY ALSO OCCUR

MODE OF OCCURRENCE

- ORES NEARLY ALWAYS OCCUR IN SEDIMENTARY CARBONATES ROCKS ESPECIALLY DOLOSTONES BUT ALSO LIMESTONES & MAGNESIAN LIMESTONES
- MAY ALSO BE FOUND IN ASSOCIATED SANDSTONES, SHALES, OR CONGLOMERATES
- MANY OF THE LARGE DEPOSITS OCCUR AS STRATIFORM MASSES (PARALLEL OR NEARLY SO WITH BEDDING); OTHERS OCCUR AS VEIN FILLINGS (OR REPLACEMENTS) ALONG FISSURES WHICH CROSS BEDDING;

- USUALLY THE CARBONATE HOST ROCK CONSTITUTES PART OF A REEF & ORES ARE LOCALIZED RELATIVE TO A PARTICULAR REEF FACIES
- ORES MAY ALSO OCCUR IN ASSOCIATION WITH A SOLUTION COLLAPSE BRECCIA RELATED TO KARST & PALAEOAQUIFER DEVELOPMENT

ORE FORMATION

- HYDROTHERMAL FLUIDS LINKED TO MVT DEPOSITS ARE
 - LOW T (100-150oC)
 - HIGH SALINITY (>15 wt% NaCl equiv) BRINES WITH APPRECIABLE SO_4^{2-} , CO_2 & CH_4
 - ASSOCIATED WITH ORGANIC COMPOUNDS & OIL-LIKE DROPLETS; THESE COMPOSITIONAL CHARACTERISTICS ARE NOT UNLIKE OIL-FIELD BRINES & REFLECT PROTRACTED FLUID RESIDENCE TIMES IN THE SEDIMENTARY BASIN
- IN MANY MVT DEPOSITS ORES OCCUR AS CEMENT BETWEEN BRECCIA FRAGMENTS INDICATING BRECCIATION OCCURRED EITHER BEFORE (AS A KARST-RELATED FEATURE) OR DURING METAL DEPOSITION

- HYDROTHERMAL DISSOLUTION OF CARBONATE NEEDS **ACIDIC FLUIDS** & COULD OCCUR BY A REACTION SUCH AS:



- FLUID ITSELF MIGHT ORIGINALLY HAVE BEEN ACIDIC OR H^+ WERE PRODUCED BY PRECIPITATION OF METAL SULPHIDES VIA:

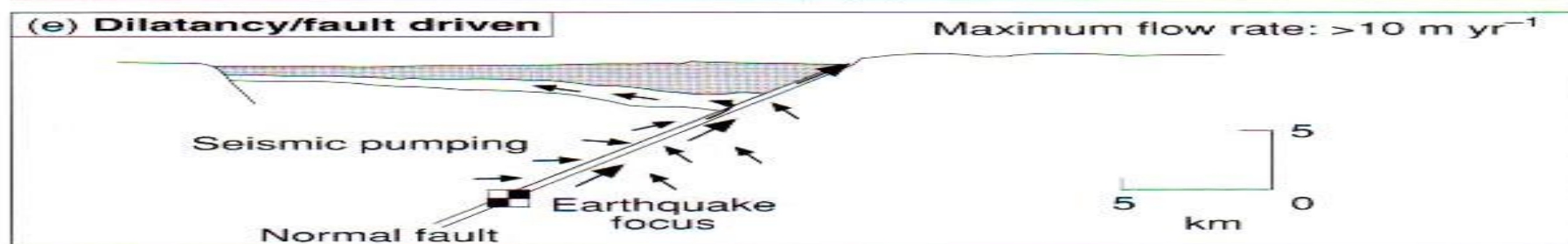
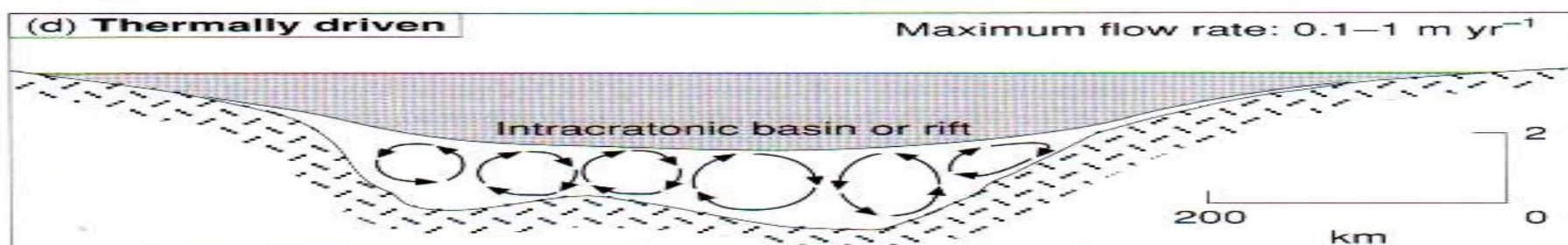
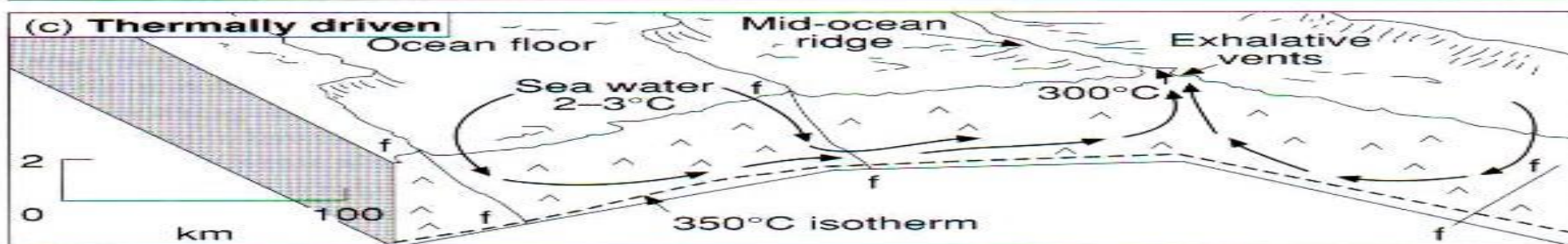
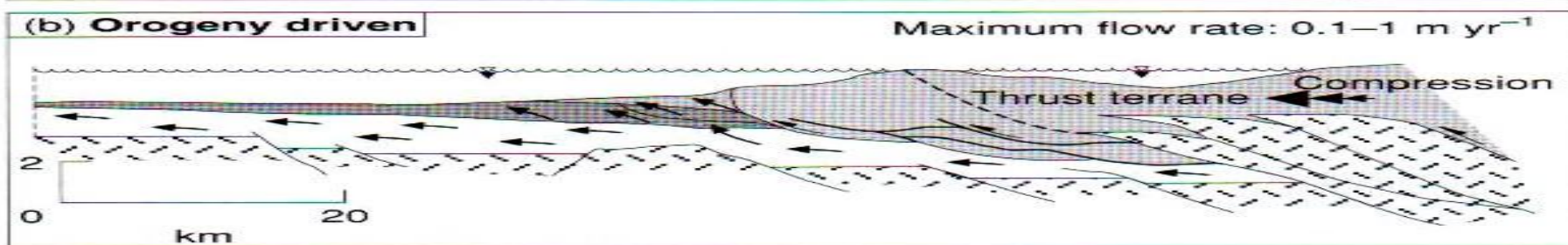
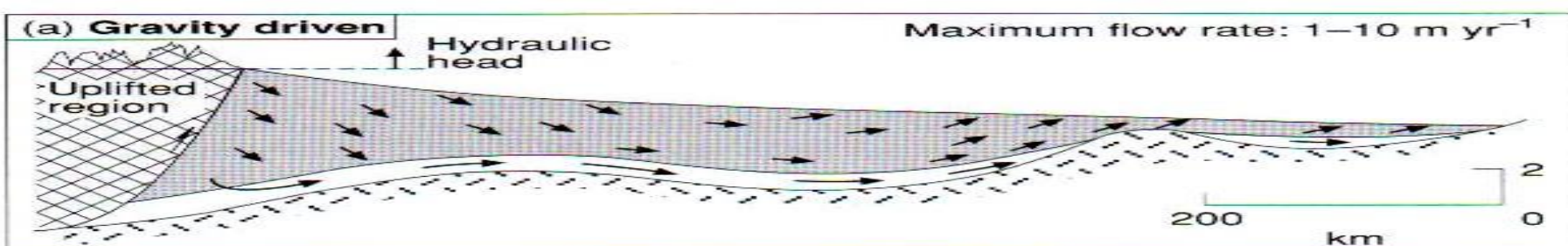


- PRODUCTION OF ADDITIONAL Ca^{2+} , Mg^{2+} & CO_2 IN THE FLUID DUE TO CARBONATE DISSOLUTION PROVIDES INGREDIENTS FOR LATER PRECIPITATION OF **CALCITE & DOLOMITE**, A FEATURE OBSERVED WHERE SECONDARY CARBONATE MINERALS **CEMENT EARLIER PRECIPITATED SULPHIDES**

- Zn & Pb BECOME SOLUBLE WHEN COMPLEXED WITH EITHER **CHLORIDE OR BISULPHIDE LIGANDS**
- AT **HIGH T & UNDER ACIDIC CONDITIONS** METAL-CHLORIDE COMPLEX TENDS TO BE MORE STABLE WHILE AT **LOW T & UNDER ALKALINE CONDITIONS** METAL-BISULPHIDE COMPLEX TEND TO DOMINATE
- THERE IS LITTLE DOUBT THAT **METAL-CHLORIDE COMPLEXES PREDOMINATE DURING FORMATION OF MVT DEPOSITS**
- CONTENTS OF CO₂ ASSOCIATED WITH SOME MVTs ARE **SUFFICIENTLY HIGH TO FORM LOW pH SOLUTIONS WHICH PROMOTE GROUND PREPARATION BY CREATING DISSOLUTION BRECCIAS AT THE SITE OF DEPOSITION**
- THIS IN TURN **RESULTS IN METAL PRECIPITATION AS ORE FLUIDS ARE NEUTRALISED BY REACTION WITH THE CARBONATE HOST ROCK**

- GENERALLY ACCEPTED THAT **TOPOGRAPHICALLY DRIVEN FLUID PATHWAYS WERE CRITICAL IN THE FORMATION OF LARGE MVT ORE DISTRICTS** & THAT **CARBONATE HOST ROCKS MAINTAINED A HYDROLOGICAL CONNECTION TO OROGENIC BELTS ACTIVE DURING DEPOSITION PERIOD**
- OTHER FEATURES THAT LINK MOST MVTs INCLUDE:
 - A LOW-LATITUDINAL SETTING WHERE HIGH RAINFALL ENSURED AN ADEQUATE FLUID RESERVOIR &
 - PRESENCE OF A HIGH-EVAPORATION SABKHA ENVIRON THAT RESULTED IN HIGH FLUID SALINITIES NECESSARY FOR VIABLE LEVELS OF METAL SOLUBILITY & TRANSPORT

- REGIONAL FLUID FLOW IS STIMULATED BY COMPRESSIONAL OROGENY THAT RESULTS IN **THRUST FAULTING & UPLIFT**
- THIS IN TURN CREATES A **TOPOGRAPHIC HEAD & FLUIDS FLOW DOWN A HYDROLOGICAL GRADIENT**
- AT SITE OF DEPOSITION MVT ORES ARE SOMETIMES **BEDDED & FOCUSED ALONG CONFORMABLE DOLOSTONE/LIMESTONE INTERFACES BUT ARE MORE ASSOCIATED WITH DISCORDANT, DISSOLUTION-RELATED BRECCIATION ZONES**



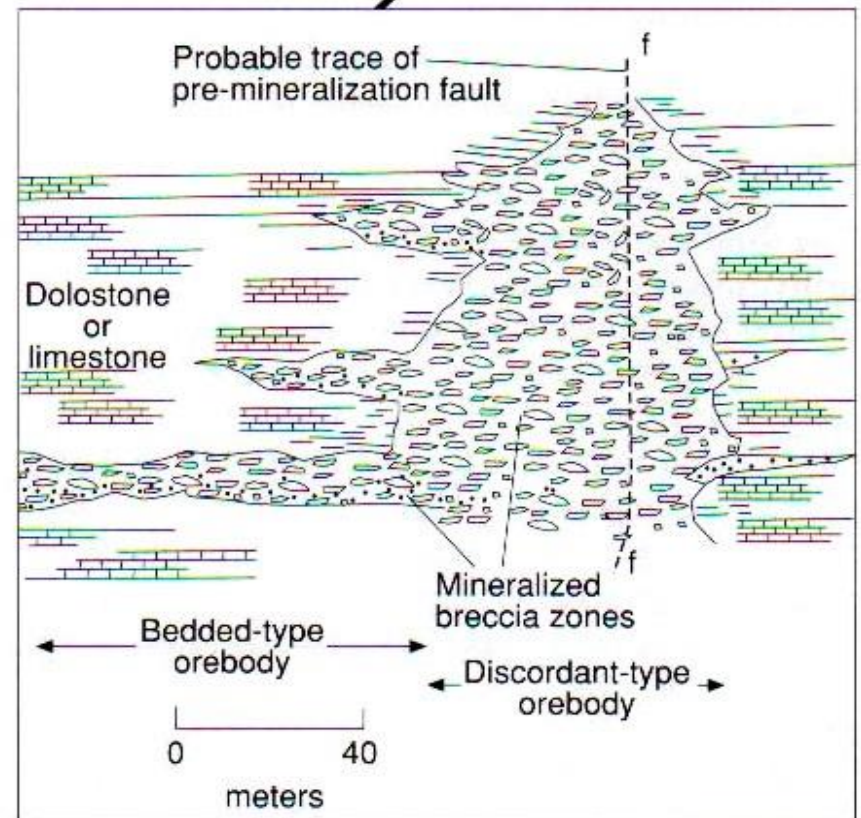
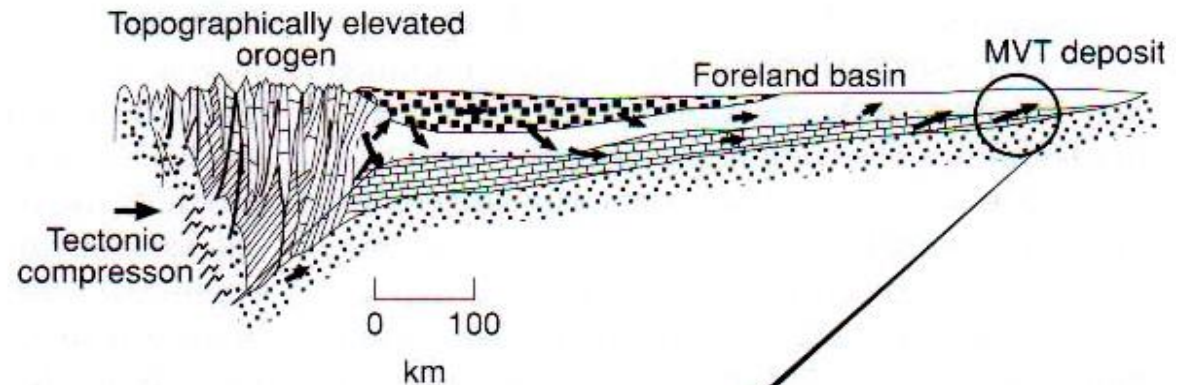


Figure 3.33 Diagram illustrating the concept of hydrological continuity between a compressional orogenic belt and a foreland sedimentary basin through which orogenically and topographically driven fluids flow, and within which MVT Zn–Pb deposits form. Inset shows characteristics of bedded and discordant mineralization at a deposit scale. Mineralization may be bedded and associated with dolostone/limestone sequences, or in discordant carbonate breccia zones (after Garven *et al.*, 1993).

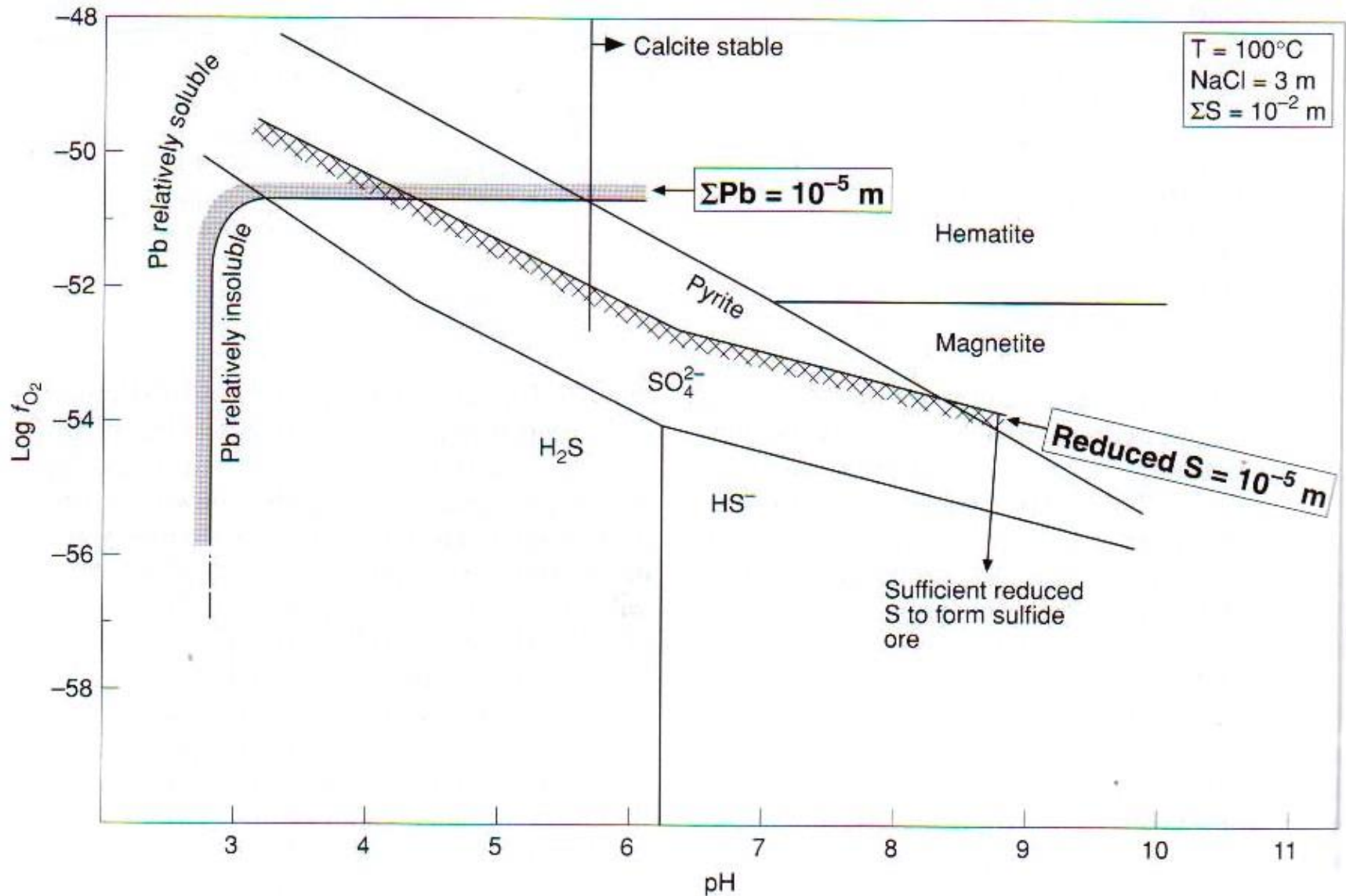


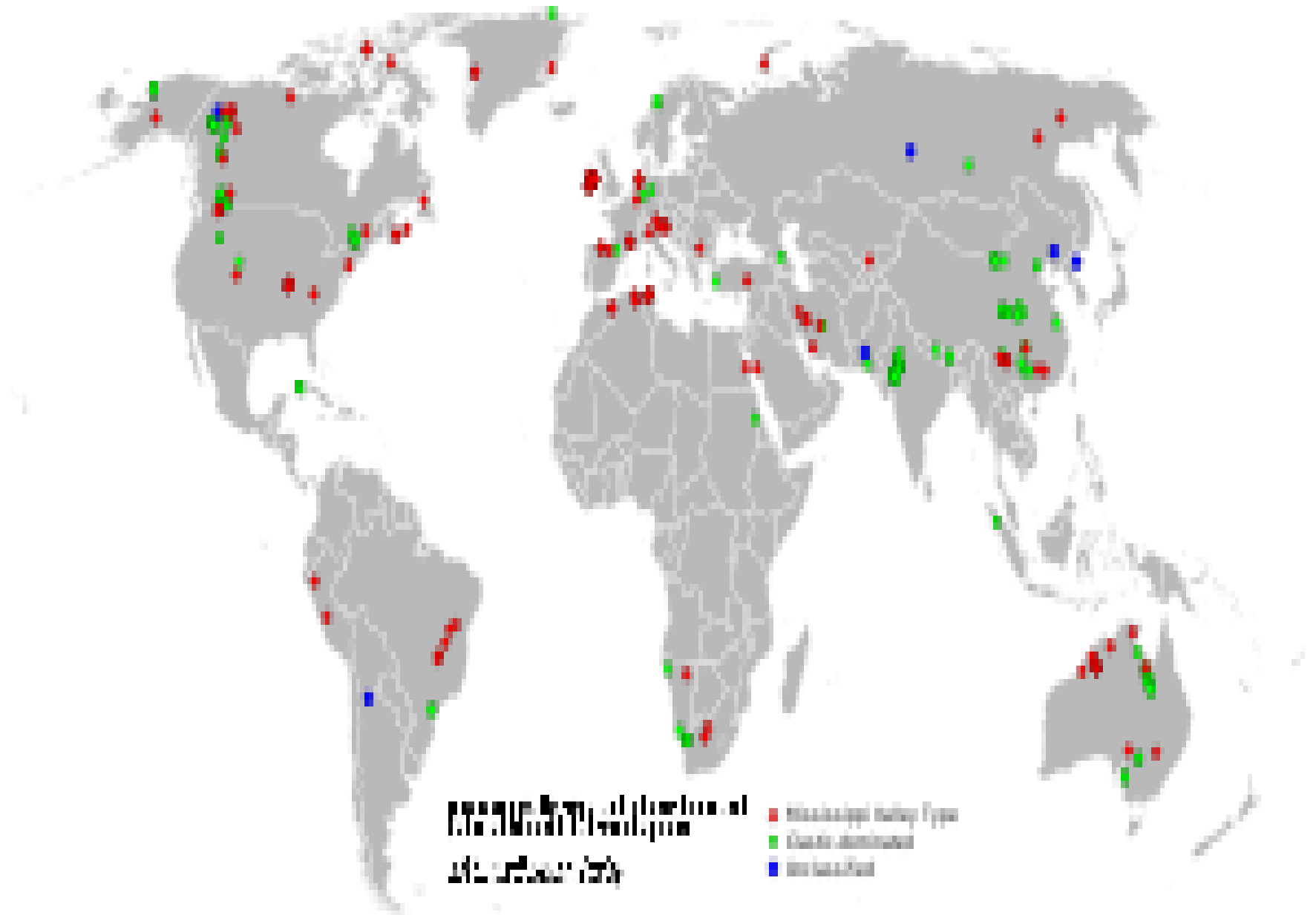
Figure 3.34 f_{O_2} -pH plot showing key mineral and aqueous species stabilities under the conditions shown. Solubility contours of $\Sigma\text{Pb} = 10^{-5} \text{ m}$ and reduced sulfur = 10^{-5} m are also shown. Higher solubilities lie to the left of and above the Pb contour, and below the sulfur contour (after Anderson, 1975).

CLASSES

- MISSISSIPPI VALLEY TYPE DEPOSITS HAVE BEEN DIVIDED INTO TWO CLASSES:
 - **MISSISSIPPI VALLEY TYPE** – WHICH ARE STRATABOUND & WERE EMPLACED AFTER LITHIFICATION OF THE HOST ROCKS (EPIGENETICALLY) INTO OPEN SPACE PROVIDED BY A VARIETY OF STRUCTURES
 - **ALPINE TYPE DEPOSITS** – WHICH ARE STRATIFORM & ALSO SYNSEDIMENTARY IN LARGE PART; ORIGINAL SOURCE OF THE ORES IS REGARDED AS CONTEMPORANEOUS WITH THE HOST ROCKS & LINKED TO SUBMARINE VOLCANISM; REMOBILIZATION MAY HAVE RESULTED CONCENTRATION OF THESE ORES & THE FORMATION OF EPIGENETIC FEATURES

DEPOSIT EXAMPLES

- MAIN METAL-PRODUCING DISTRICTS INCLUDE:
 - VIBURNUM TREND OF SOUTHEAST MISSOURI (MAINLY Pb)
 - TRI-STATE (I.E OKLAHOMA, KANSAS & MISSOURI) REGION
 - ILLINOIS-WISCONSIN REGION & MASCOT-JEFFERSON REGION OF EAST TENNESSEE
- OTHER WELL KNOWN DEPOSITS ARE:
 - PINE POINT & POLARIS OF NORTHERN CANADA
 - SILESIAN DISTRICT OF POLAND
 - MECHERNICH OF AUSTRIA
 - LENNARD SHELF DISTRICT, SORBY HILLS & COXCO OF AUSTRALIA
 - PERING IN SOUTH AFRICA
 - **KABWE OF ZAMBIA?**



LOCATION MAP OF MVT DEPOSITS