What is a Sediment Hosted Vein Deposit?

The term Sediment Hosted Vein (SHV) deposit is used for a family of gold deposits that consist of gold in quartz veins hosted by shale and siltstone sedimentary rocks. These deposits occur throughout the world, but are most prolific in size and number in Asia. A few SHV deposits are well known and previously have been described by other names such as turbidite-hosted, shale-hosted, slate-belt, or mesothermal vein deposits. Most are poorly known to westerners because of their location in the former Soviet Union. More recently, these and other non-SHV deposits have been grouped under the term Orogenic deposits.

SHV gold deposits are some of the largest in the world. In Asia, examples are Muruntau (>80M oz), Sukhoy Log (>20M oz), Amantaytau, Daugiztau, Kumtor, Bakirchik, Olympiada, Nezhdaninskoe, Natalka, and Maysky (all > 5M oz). In Australia, the numerous deposits of the Victorian gold fields include Bendigo (>20Moz), Ballarat, Fosterville, and Stawell. In New Zealand, Macraes Flat (~5M oz) and numerous small deposits are hosted by the Otago Schist Belt. In South America, pre-Cordillera rocks of Peru, Bolivia, and Argentina host enumerable small to medium deposits with past production from pre-European time. In North America, numerous small to medium deposits occur in the Meguma Terrane of Nova Scotia and in the southern half of the Seward Peninsula, Alaska.

All of these deposits have characteristics in common which define them as a group and can be used for exploration purposes.

What are the characteristics of Sediment Hosted Vein deposits?

All SHV deposits have characteristics in common with each other. Understanding these characteristics allows explorationists to predict the existence of undiscovered deposits when these characteristics are identified in new places. Features in common that that unite SHV deposits as a group include their tectonic setting, host rocks, alteration style, metal content, hydrothermal fluid chemistry, and to some extent, absolute and relative timing of formation.

SHV deposits are hosted in extensive belts of shale and

siltstone sedimentary rocks that cover thousands of square kilometers. These rocks were originally deposited in thick sequences along the edges of continents known as passive margin settings. This type of setting is specific and identifiable among sedimentary belts of the world. It is also distinct and different to smaller sedimentary belts that occur along tectonically active continental margins such as in southeast Alaska.

Some of these sedimentary belts have undergone fold - thrust deformation and those that have, are candidates for hosting SHV deposits. This style of deformation is important in the creation SHV deposits for two reasons. First, it helps to generate the hydrothermal fluids that transport and deposit the gold. And second, it produces the structural architecture that enables the fluids to pass upward through the crust to a location where a gold deposit can form. Other important tectonic and structural controls include proximity to continental basement, the presence of cross structures, and multiple episodes of deformation. Also, SHV deposits typically form within anticlines. These are all features that explorationists can identify and utilize in the search for SHV type deposits.

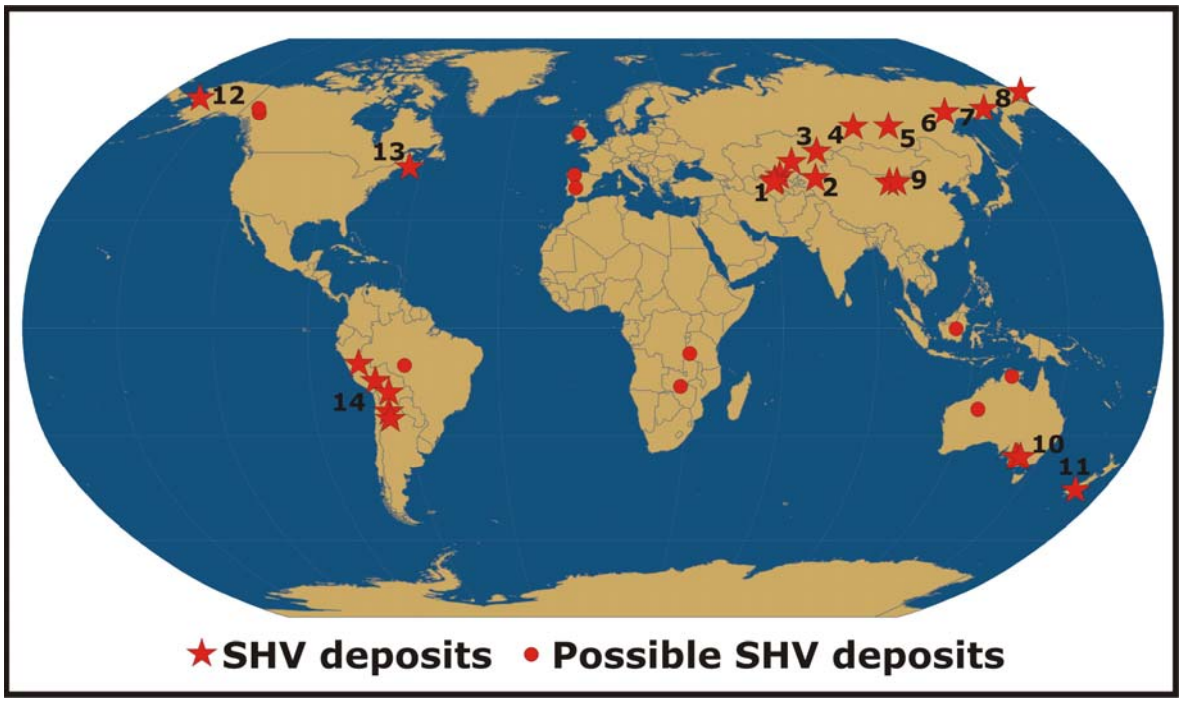
Quartz and quartz-carbonate veins with gold are the hallmark of SHV type deposits. These veins form from fluids which commonly leave a subtle but distinctive alteration signature. For example, carbonate alteration is most prevalent. Also, the formation of sericite – an alteration mineral - and bleaching of host rocks is common. At the surface, these altered rocks weather and produce subtle pastel colors – khaki, mauve, and yellow brown or a sandy-colored bleached appearance. Iron pyrite is usually introduced with alteration leaving fine to large pyrite cubes scattered throughout the host rock, particularly near veins.

One attractive characteristic of SHV deposits from the mining standpoint is that they can be gold-only systems and therefore are metallurgically simple. Other metals and minerals that can be associated with the gold include trace to minor amounts of arsenopyrite and stibnite, W, Bi, and Te. Generally there is a paucity of Cu, Pb, and Zn sulfides but minor amounts occur in a few deposits. Overall, sulfide content is low for this type of deposit.

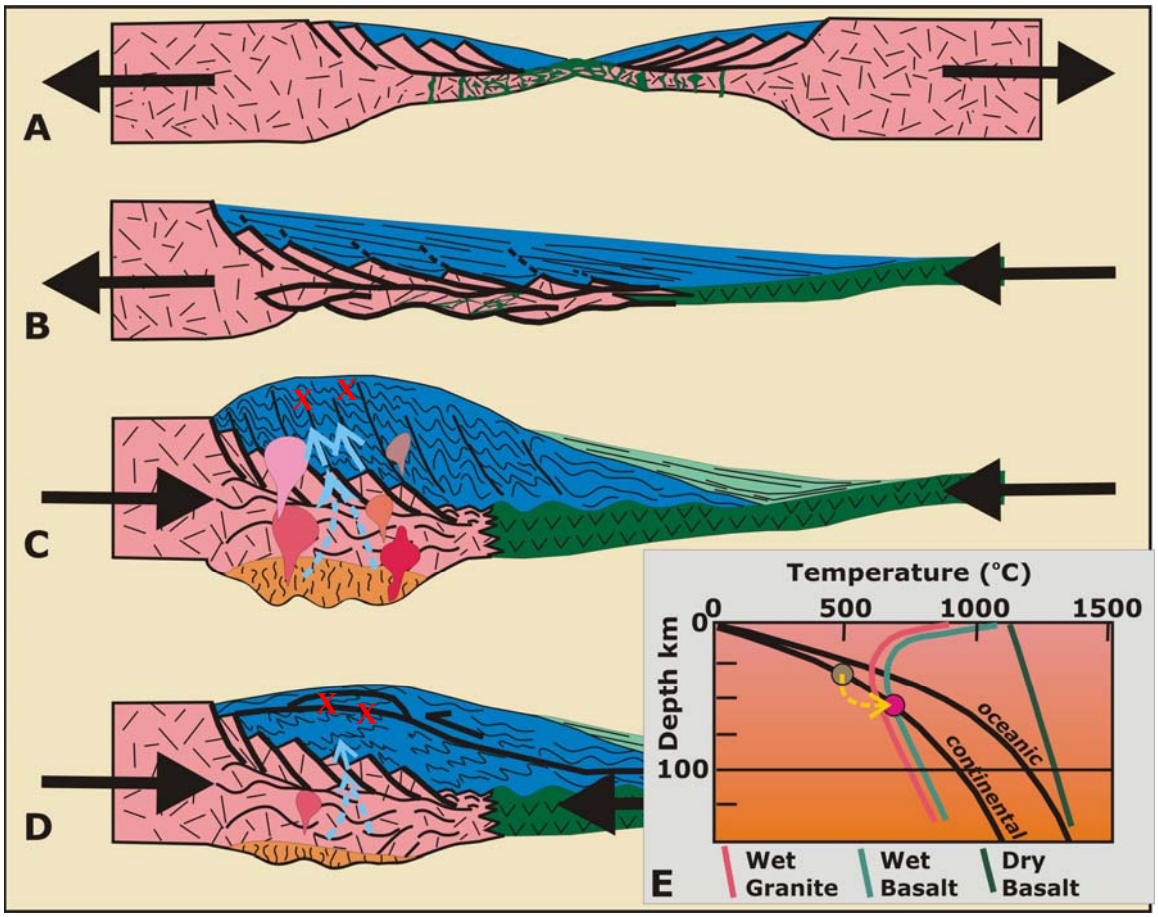
Some other important characteristics.

- SHV deposits usually occur in rocks of late Proterozoic to early Paleozoic age.
- SHV deposits are associated with prolific placer gold fields if conditions are right for the formation of placer deposits.
- SHV deposits occur in groups, usually with one large deposit associated with numerous satellite deposits.
- Granitic rocks commonly, but not always, occur in spatial association with SHV deposits. The timing of granite intrusion can be before or after mineralization.
- The age of most SHV mineralization is mid to late Paleozoic. Some are younger.

Where in the world are SHV deposits?

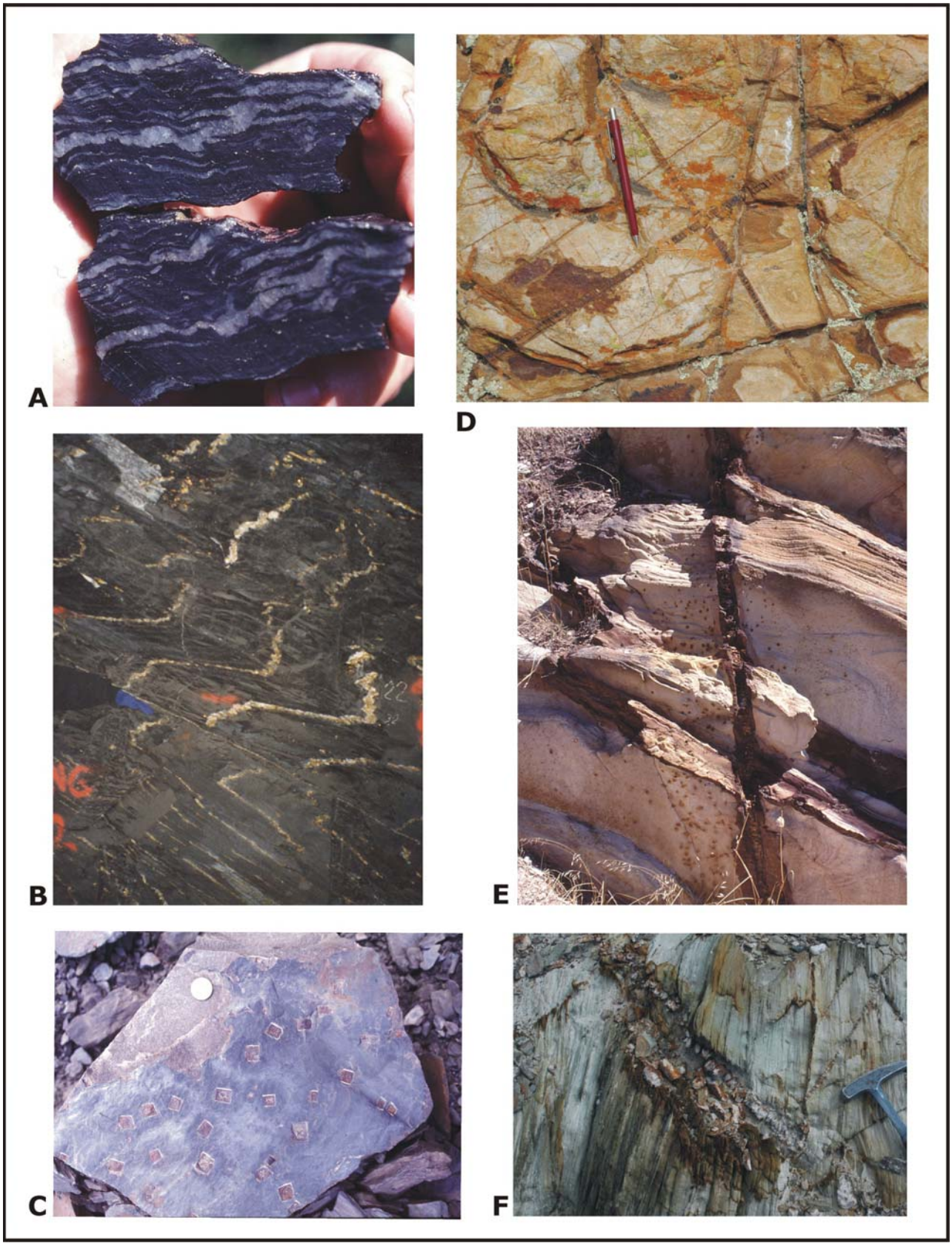


Location map showing key Sediment Hosted Vein deposits of the world. 1. Muruntau -80M oz; Daugiztau - 8.4M oz; Amantaytau - ~5M oz; 2. Kumtor - >7M oz; 3.Bakirchik - 8.2M oz; 4. Olympiada - 8M oz; 5. Sukhoy Log - 20M oz; 6. Nezhdaninskoe - 16M oz; 7. Kolyma - Magadan area; Natalka - 6.7M oz; 8. Maysky - 9M oz; 9. Inner Mongolia; numerous small to medium deposits; 10. Victorian Goldfields including Bendigo - >20M oz, Ballarat, Fosterville, Stawell, and many smaller deposits; 11. Macres Flat - 5.2M oz; 12. Seward Peninsula; numerous small to medium deposits; extensive beach placers; 13. Meguma terrane deposits; numerous small to medium sized deposits; 14. pre-Cordillera Belt; numerous small to medium deposits.

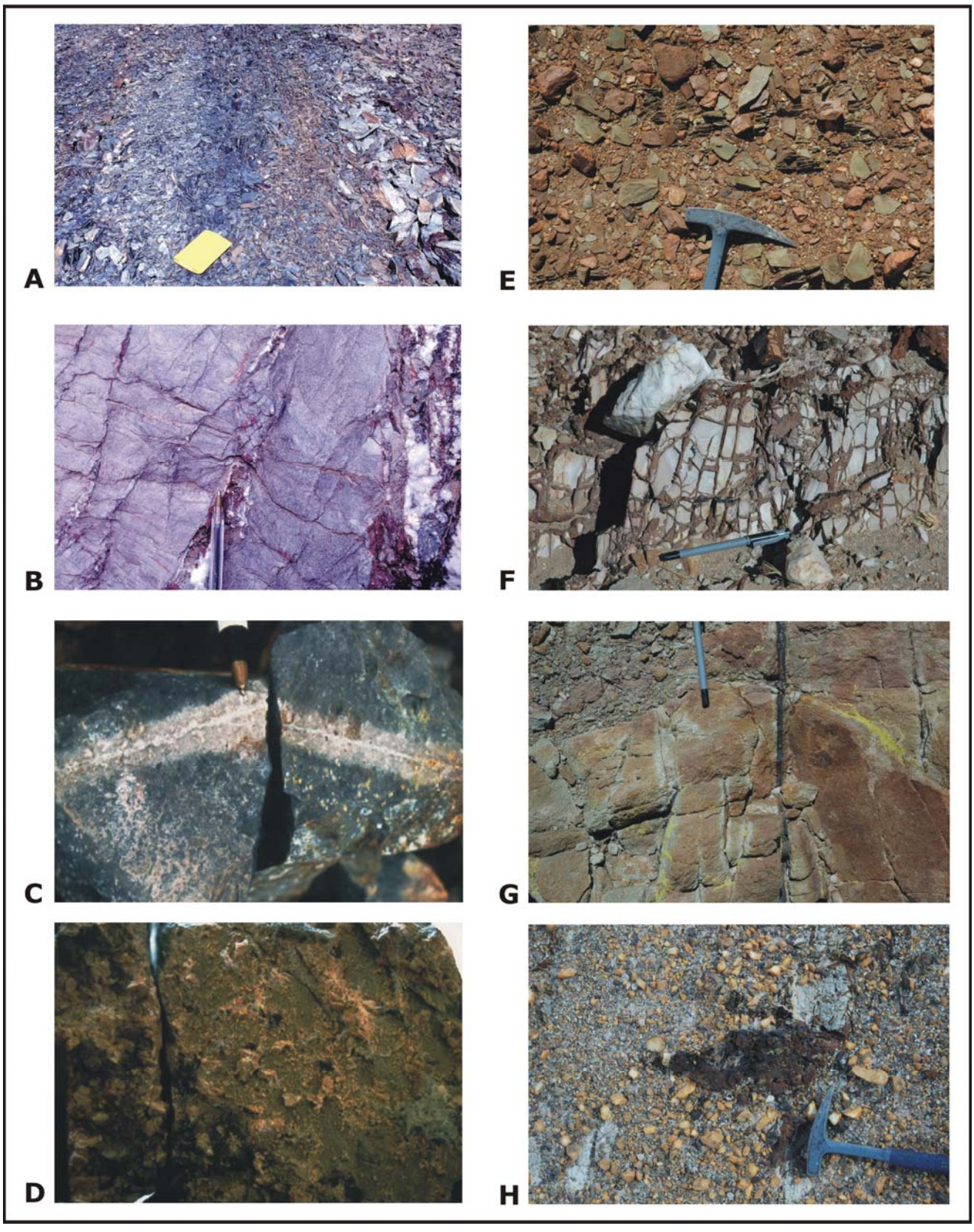


Schematic diagram showing development of passive margin settings and SHV style mineralization. A) Continental crust is rifted, and extended. B) Mature passive margin setting. Thick sedimentary sequence overlies attenuated, structurally unstable continental crust. Growth faults propagate upward from faulted basement as the sediment loading progresses. C) and D) Different styles of fold thrust deformation produce alternate scenarios. Crustal thickening produces granitic melts and hydrothermal fluids. E) Thickened crust follows a path approximated by the yellow dashed line. If this path crosses a melting curve, magma will be produced.

What do these rocks look like?



Host rock photos. A) layer parallel, deformed quartz veins in black shale; Muruntau. B) folded and boudinaged layer parallel quartz-carbonate-sulfide veining and sulfide veining along shallow reverse fault offset (at blue gloved hand); Sukhoy Log.
C) Coarse euhedral pyrite associated with carbonate alteration in shaley siltstone; Muruntau. D) quartz veinlets in altered siltstone; Minas Azules. E) Quartz-carbonate-sulfide vein with surrounding envelope of euhedral pyrite and Arsenopyrite; in altered siltstone; Victoria, Australia. F) Quartz-carbonate-sulfide vein fills sinistral shear feature in foliated, altered shale; Incahuasi.



Examples of SHV alteration. A) Khaki and pastel hues in sericite and carbonate-altered shale; Sukhoy Log. B) Bleached siltstone with carbonate and quartz-carbonate veinlets;

Amantaytau. C) Sericite and carbonate-rich alteration envelope around quartz veinlet; Victoria. D) Albite coats a fracture surface between host rock and vein (broken away). E) Khaki and pastel-colored carbonate-altered shale at Toro. F) Chocolate brown weathered carbonate veins in sericite-altered (bleached) siltstone. G) bleached alteration envelopes after sericite around quartz-carbonate-sulfide veinlets (Toro). H) Chocolate brown weathered carbonate-quartz-sulfide vein in altered shale and siltstone. Chips are stained bale brown from altered carbonate.