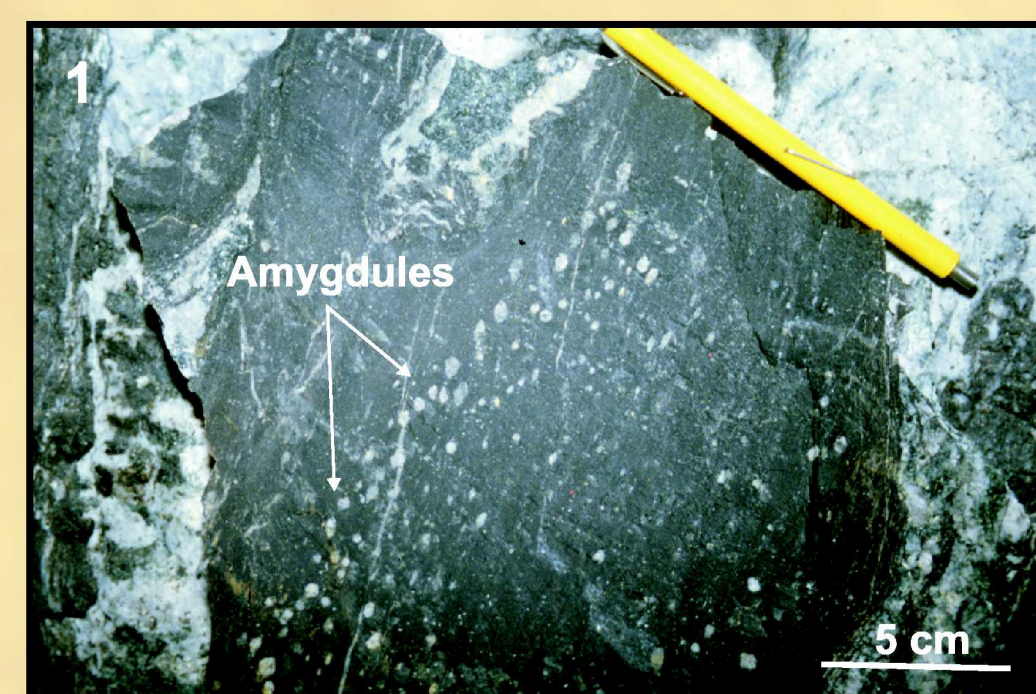


# The GOLDCORP High Grade Zone, Red Lake Mine, Ontario: a photographic Atlas of the main geological features<sup>\*-1</sup>

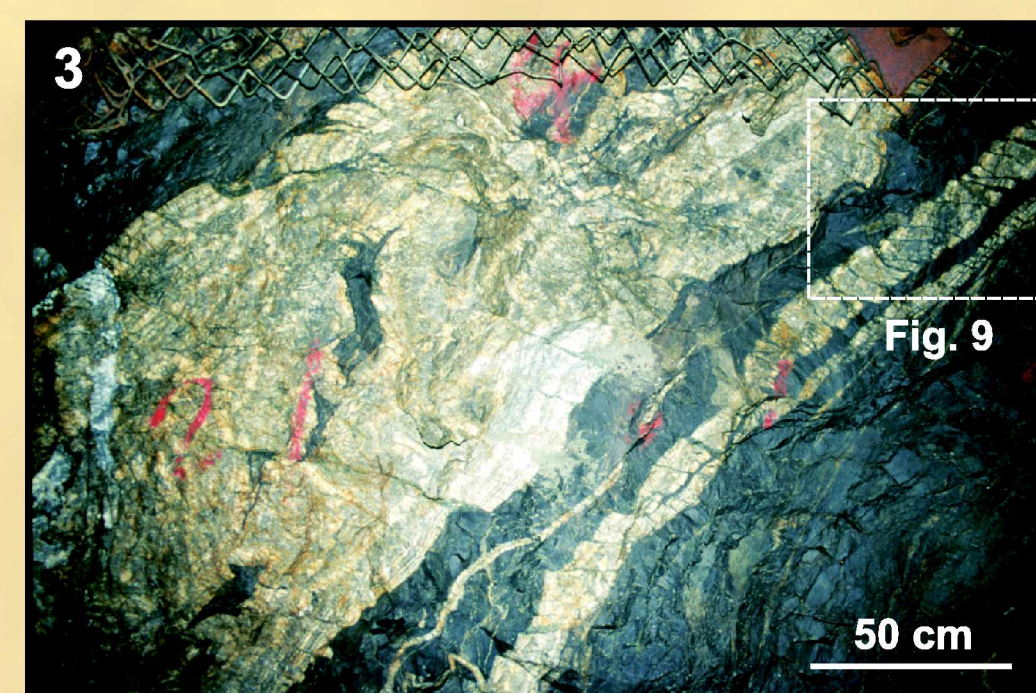
**cgq** centre  
géoscientifique  
de québec

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A GSC-GOLDCORP Inc joint project

1- Contribution to Western Superior NATMAP  
2- Geological Survey of Canada (GSC-Québec), Québec, Québec  
3- INRS-Géoressources, Québec, Québec



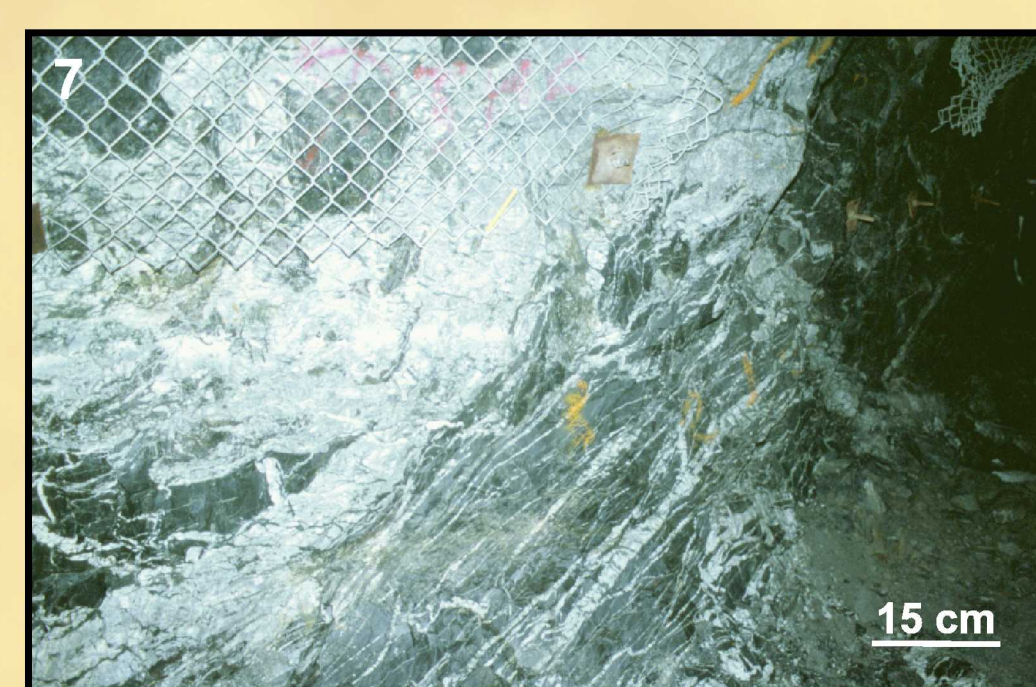
Weakly deformed amygdulites in basalt located in lower strain  $F_2$  fold nose. Section view at high angle to  $S_2$  (34-786-4 EDR). GSC 2001-020A.



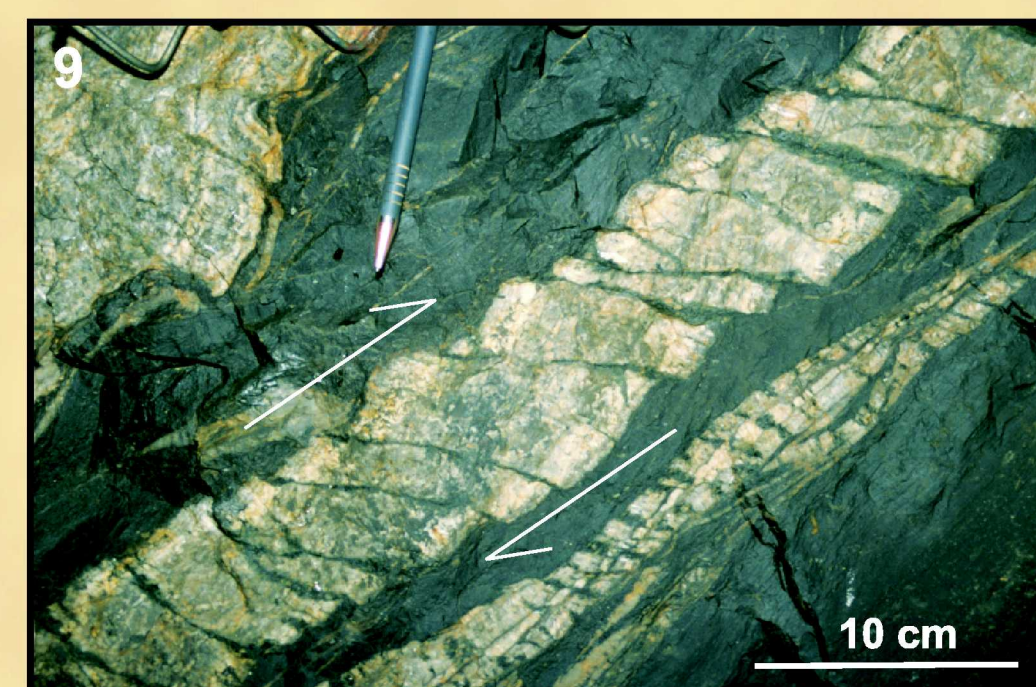
NW-trending type 3 carbonate breccia vein with colloform-cockade breccia texture. Section view (31-826-2 Ramp). GSC 2001-020C



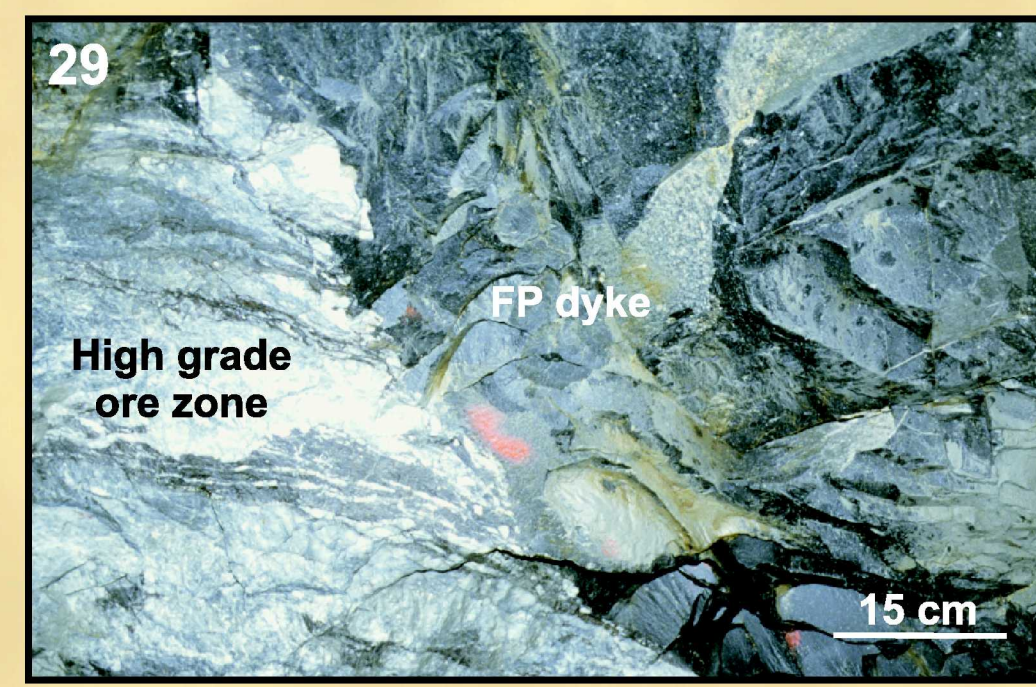
Carbonate breccia vein interpreted as a dilational jog. Section view (34-786-1 SXC). GSC 2001-020E.



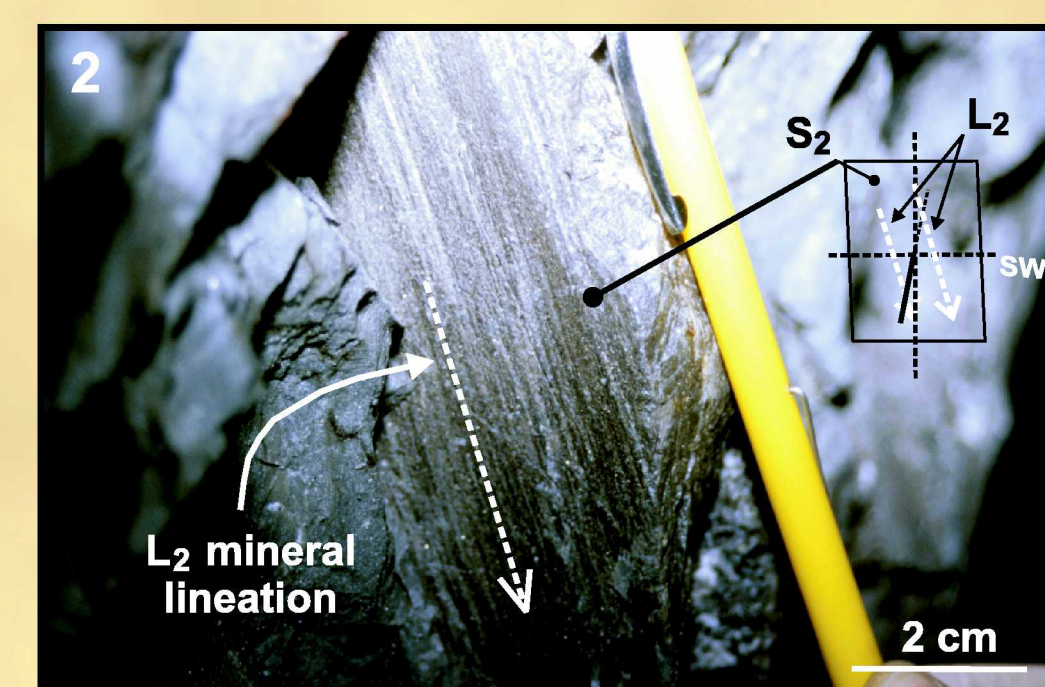
Carbonate breccia vein (dilational jog) with associated  $S_2$ -parallel crustiform carbonate veins. Oblique section view (34-786-1 SXC). GSC 2001-020G.



Asymmetric boudins deforming colloform carbonate vein, hanging wall side up. Section view (31-826-2 Ramp). GSC 2001-020I.



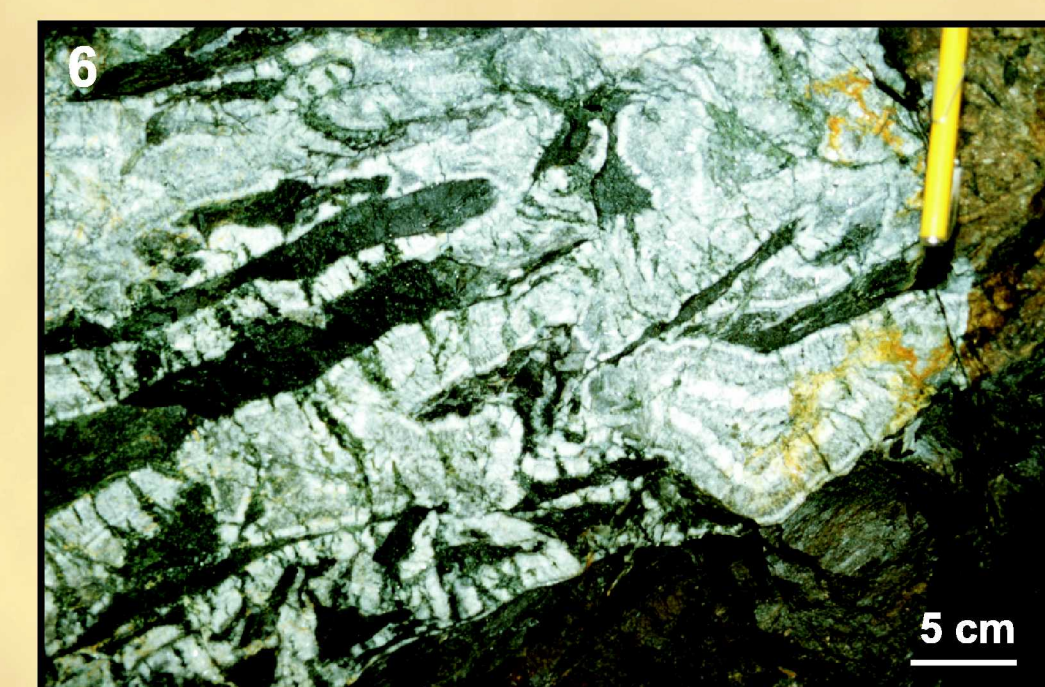
Post-ore foliated FP dyke cutting across high grade ore as seen on the back of the 32-826-8 WDR stope. This particular dyke has been sampled for geochronology. GSC 2001-020AA.



Section view parallel to  $S_2$  of steeply SW-plunging  $L_2$  mineral lineation (34-806-4 WDR). GSC 2001-020B.



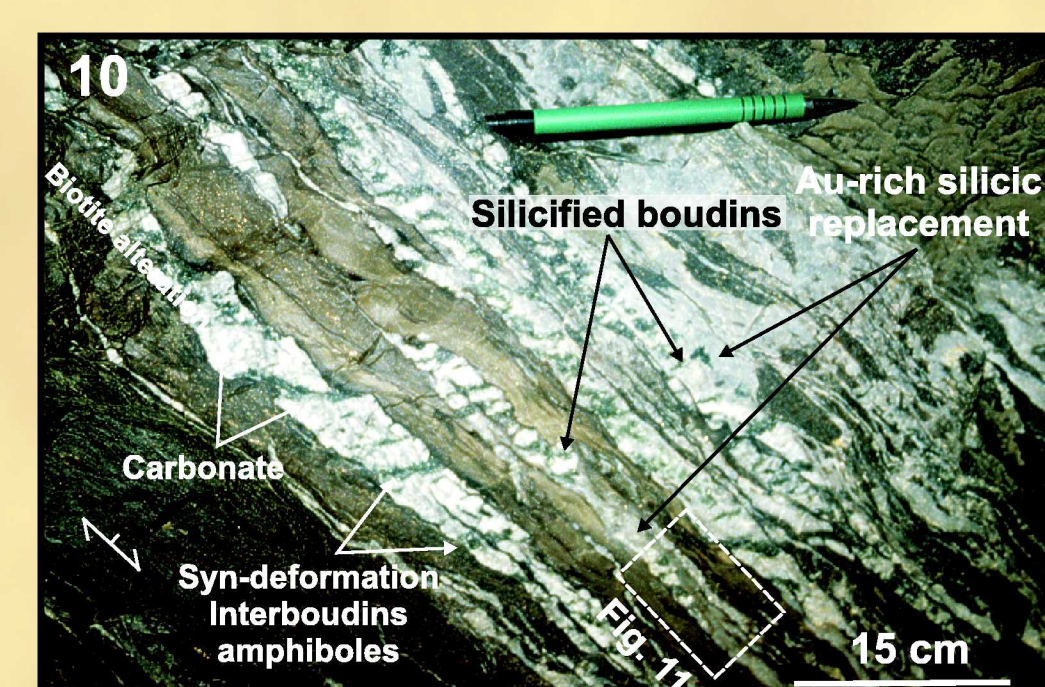
Jigsaw-puzzle carbonate breccia vein hosting angular basalt fragments. Section view (31-826-2 Ramp). GSC 2001-020D.



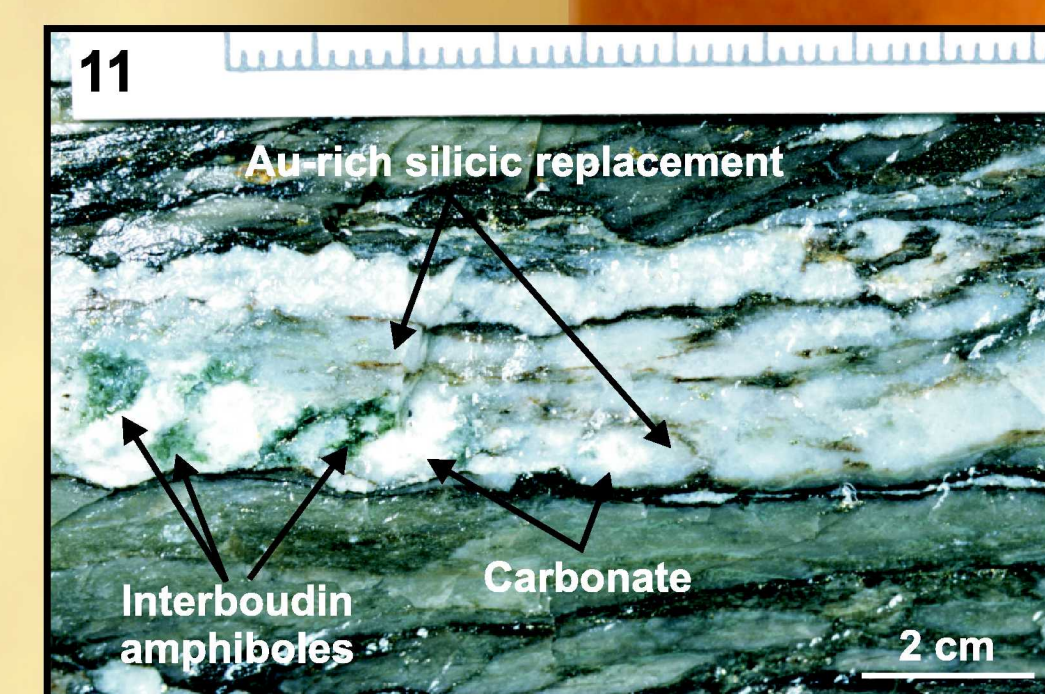
Colloform and cockade textures in carbonate extensional breccia veins. Section view (31-826-2 Ramp). GSC 2001-020F.



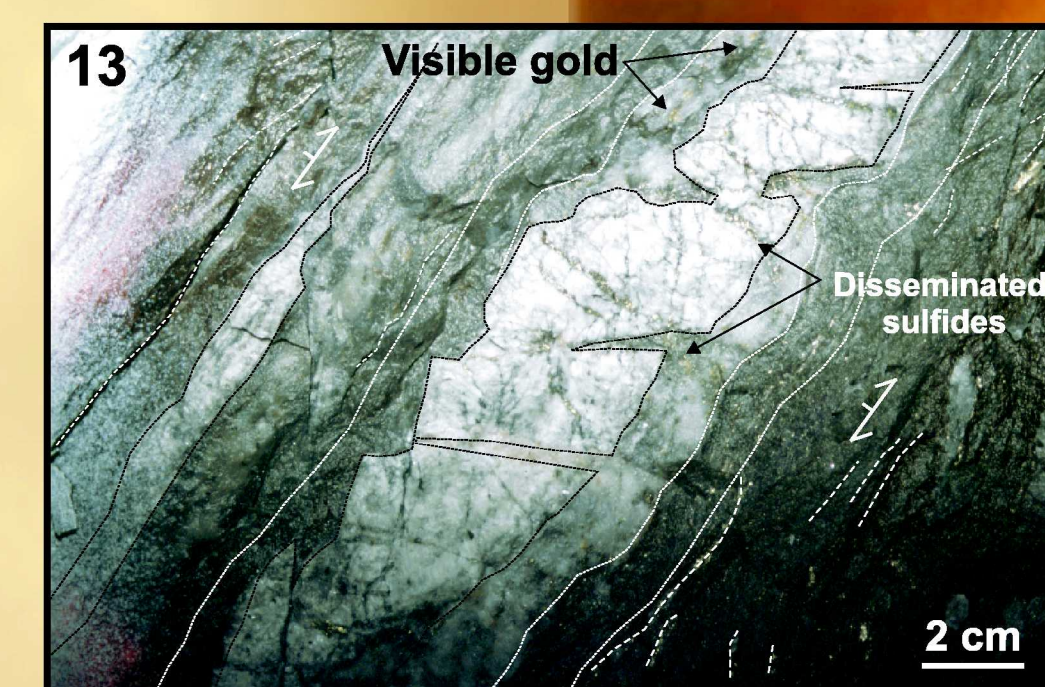
Stockwork and sheeted carbonate veins hosted by basaltic komatiite. Looking at the back of 34-826-1 EDR drift. GSC 2001-020H.



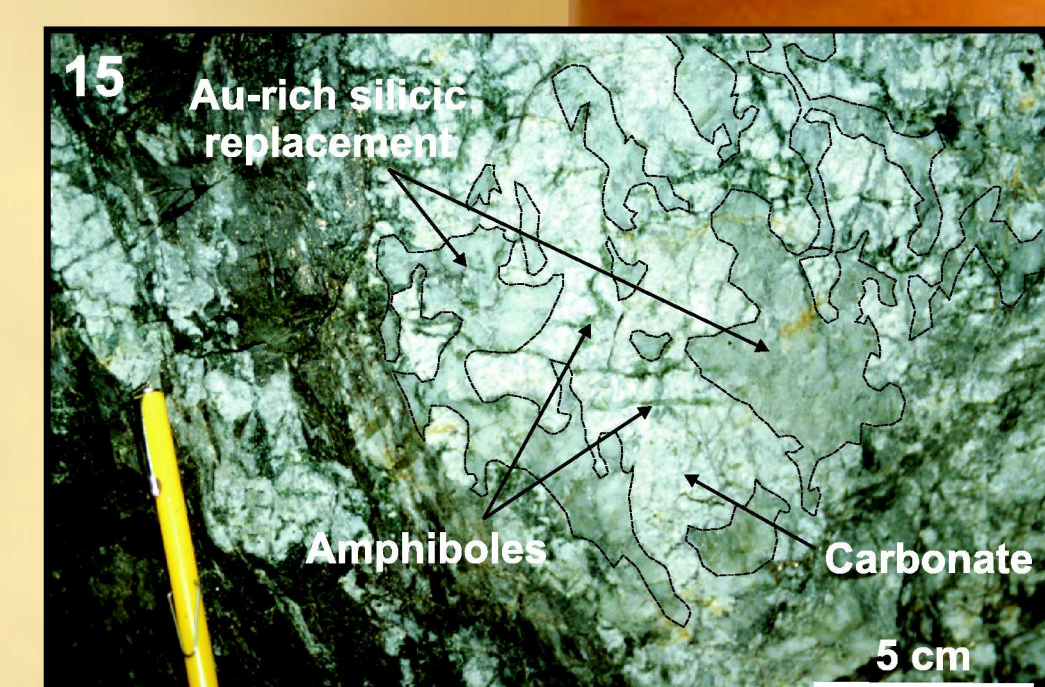
Asymmetric boudins deforming  $S_2$ -parallel extensional carbonate veins, replaced by Au-rich quartz; hanging wall side up. Section view (34-786-3 EDR). See figure 11. GSC 2001-020J.



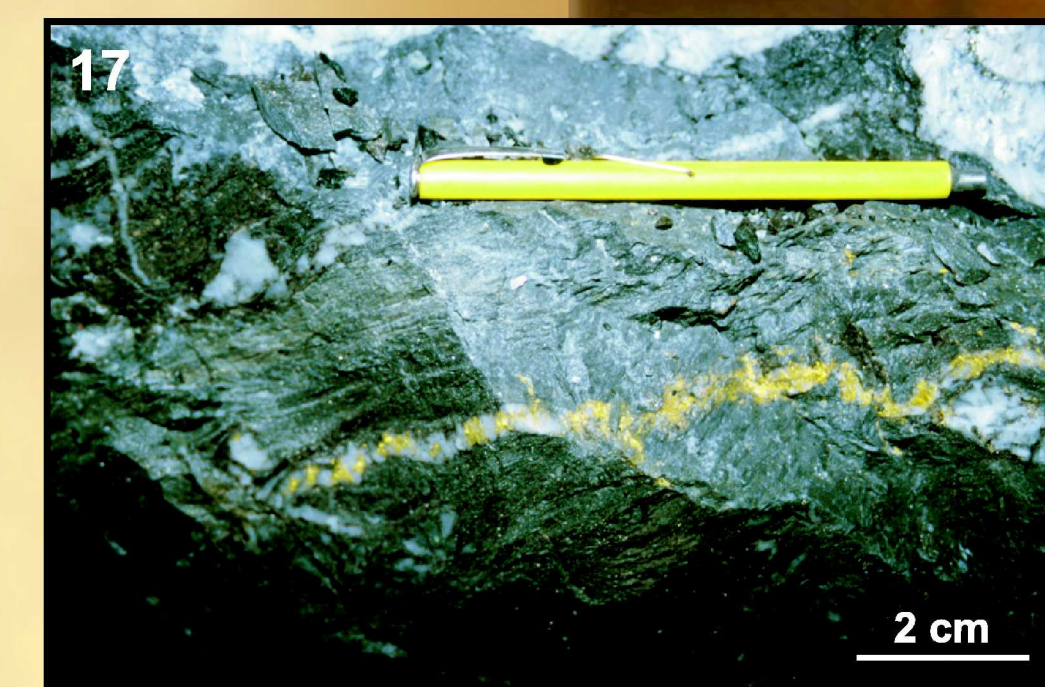
Au-rich silica replacing previously boudinaged carbonate vein as well as the amphibole in pull aparts. Section view (34-786-3 EDR). See figure 12. GSC 2001-020K.



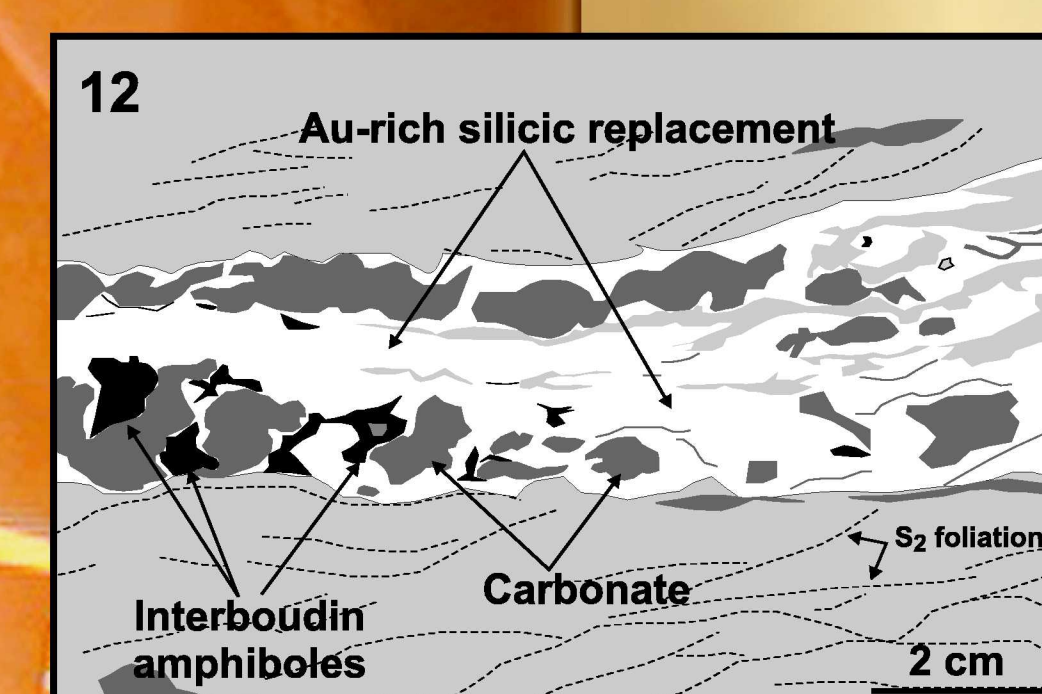
Asymmetric boudinage of a  $S_2$ -parallel carbonate vein, partly replaced by high grade Au-rich silica with quartz filling pull aparts. Both carbonate vein and silica are locally cut by sub-horizontal shear fracture. Section view (34-806-8 WDR). See figure 14. GSC 2001-020L.



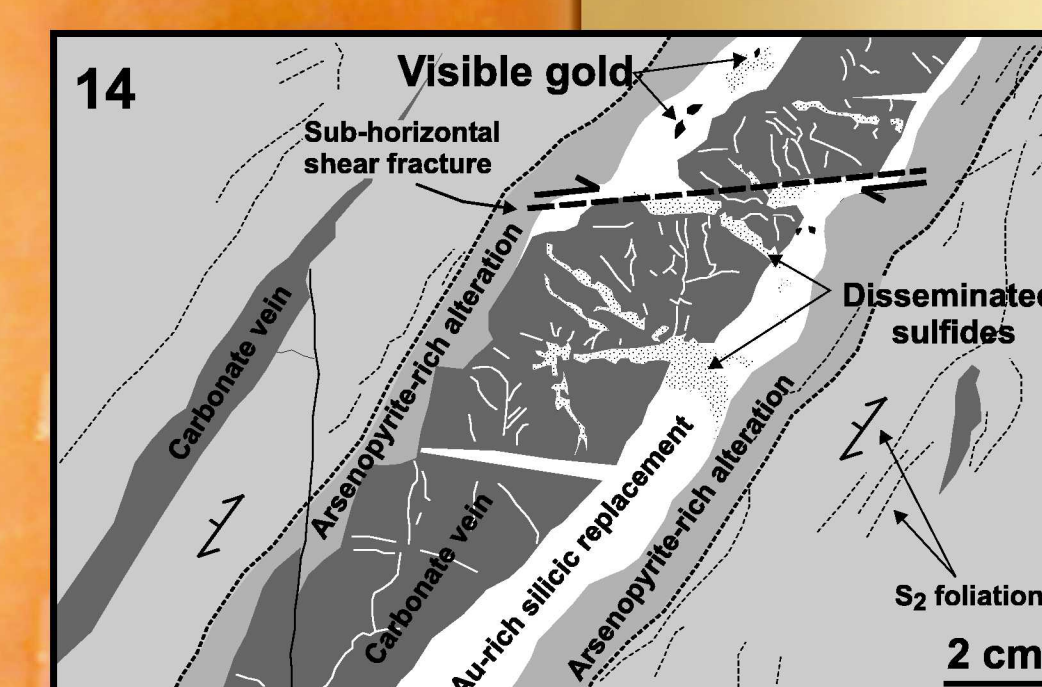
Au-rich silica replacing a  $S_2$ -parallel barren colloform carbonate vein. Section view (34-806-4 WDR). GSC 2001-020M.



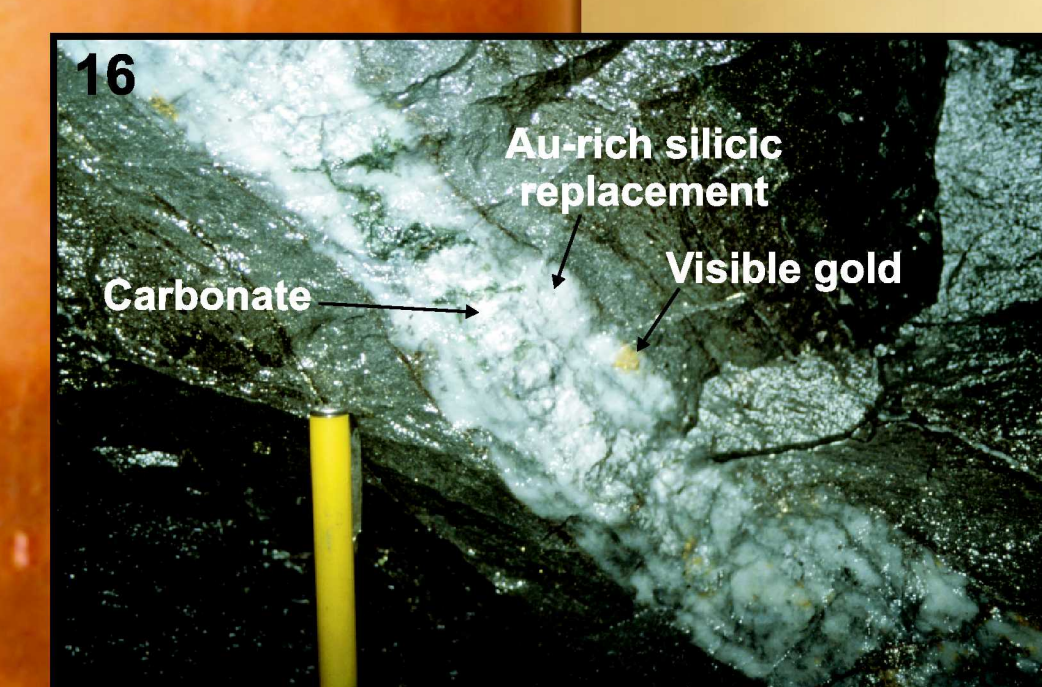
Extensional carbonate veinlet replaced by quartz containing abundant visible gold. The veinlet cuts replacement-breccia style ore (34-806-1 WDR). GSC 2001-020O.



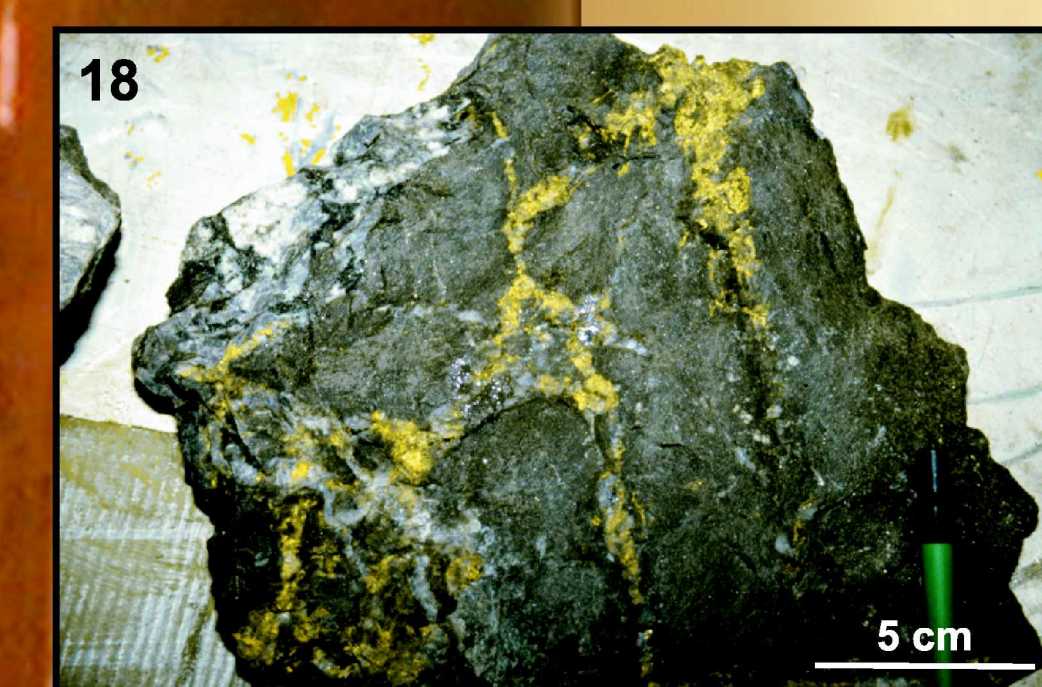
Drawing of figure 11.



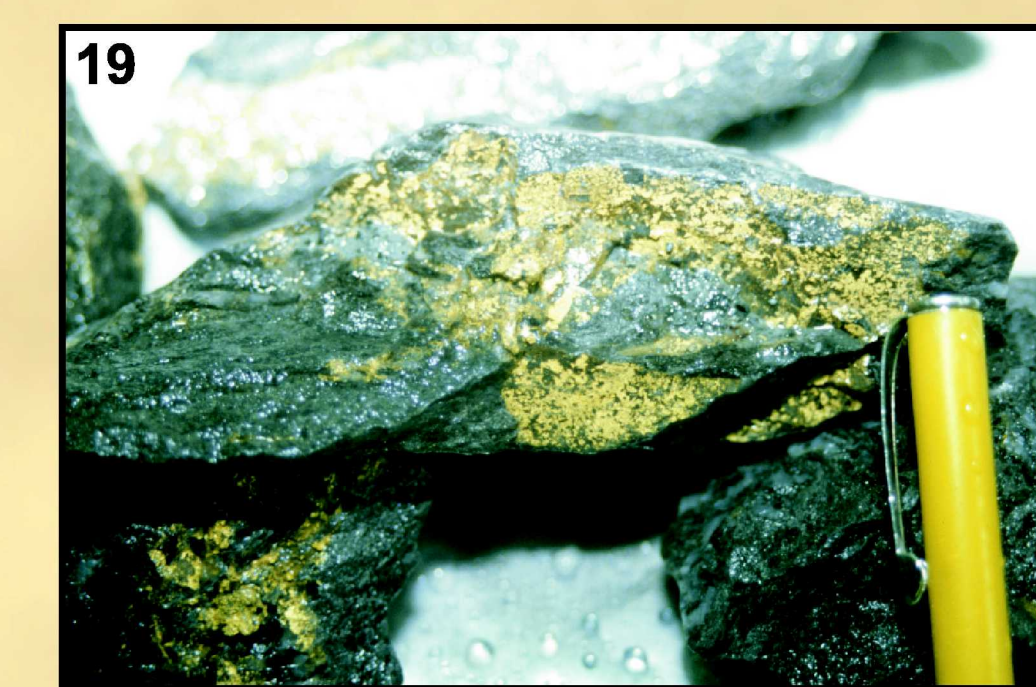
Drawing of figure 13.



High grade Au-rich silica replacement of a colloform carbonate vein. Oblique section view (HW 5 shear; 34-806-5 WDR). GSC 2001-020N.



Late gold veinlets stockwork as an example of extreme high grade ore found in the High Grade Zone on 34 level. GSC 2001-020P.



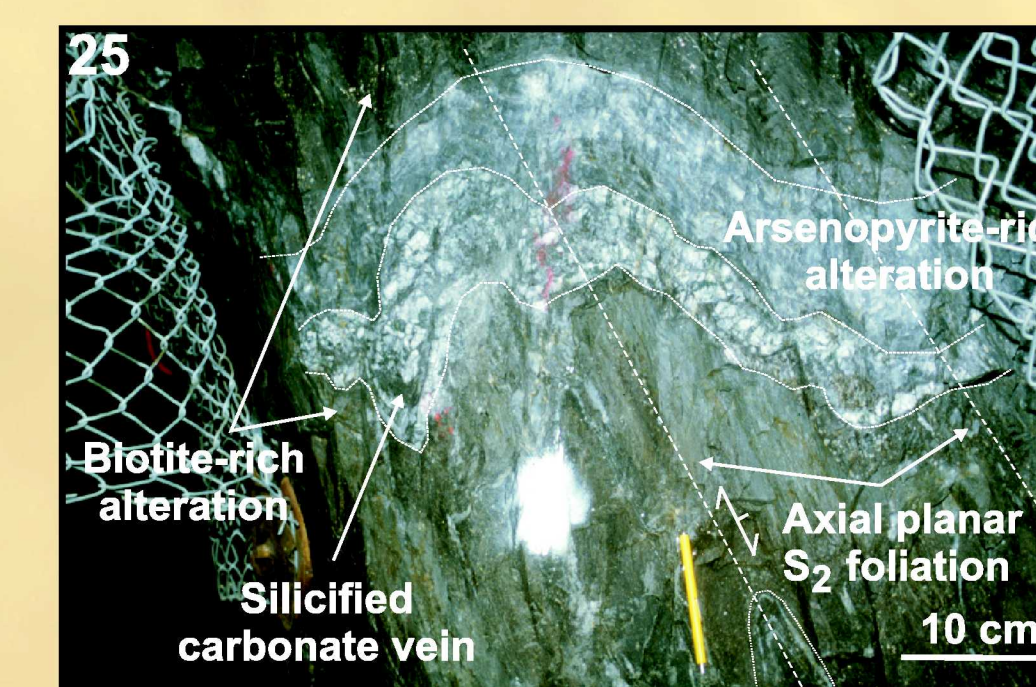
Example of extreme high grade ore found in the High Grade Zone on 34 level. GSC 2001-020Q.



Six inches diameter core showing visible gold coating a late brittle fracture plan, which is at high angle to the main  $S_2$  foliation. GSC 2001-020S.



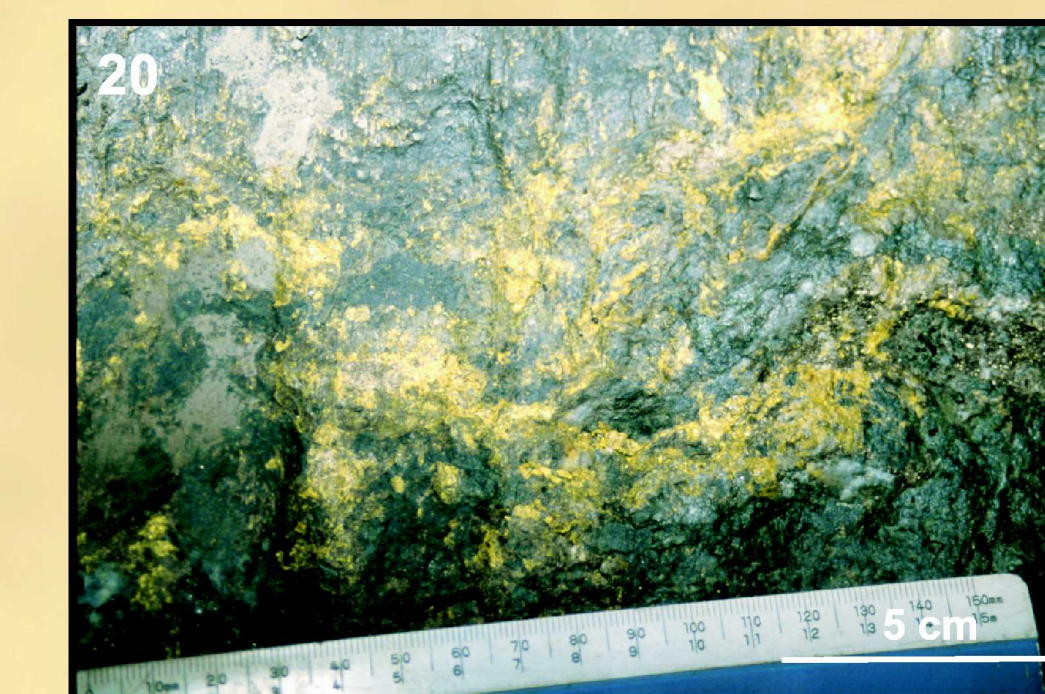
Folded silicified carbonate vein with visible gold coating the axial planar cleavage (HW 5; 34-806-5 WDR). See figure 24. GSC 2001-020U.



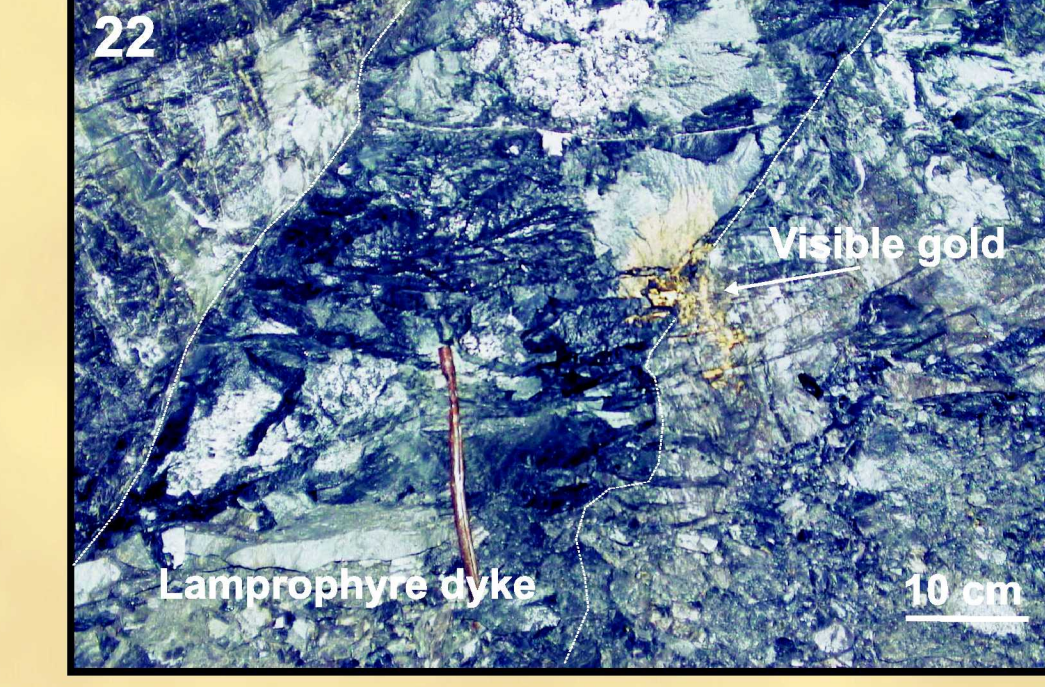
Shallow-dipping high grade arsenopyrite-rich silicified carbonate vein and selvages folded by  $F_2$ . Section view (34-786-4 EDR). GSC 2001-020W.



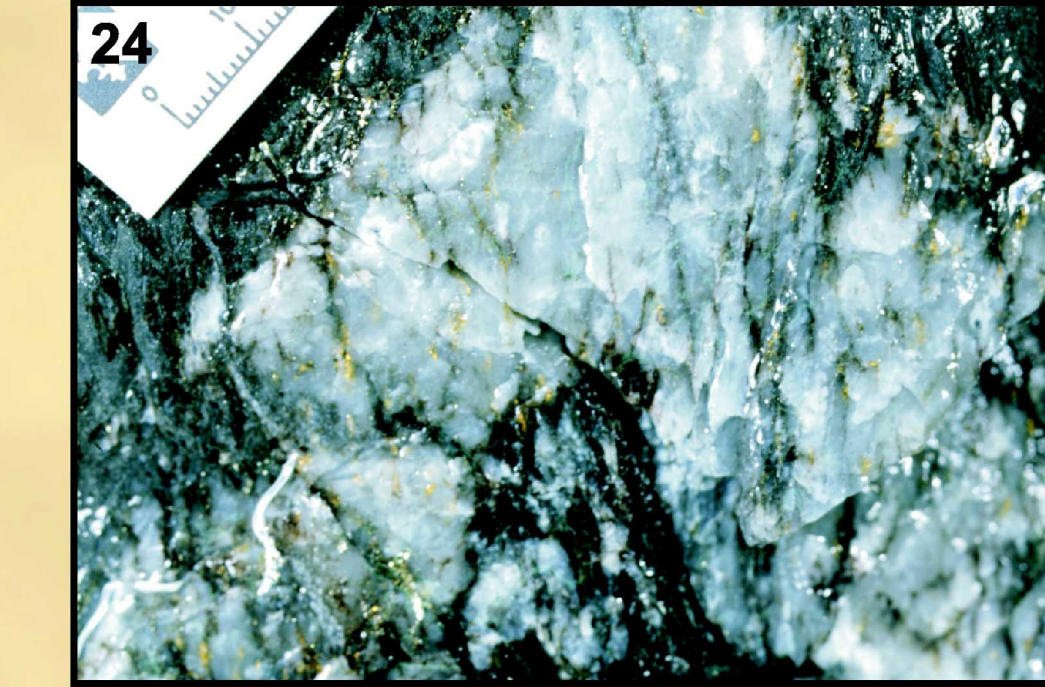
$S_2$ -parallel Au-rich silicified carbonate vein in the high strain HW shear, with strongly foliated biotite alteration selvages (34-806-4 WDR). See figure 28. GSC 2001-020Y.



Visible gold coating an irregular fracture plane in highly foliated rock. Looking at the floor (34-806-1 WDR). GSC 2001-020R.



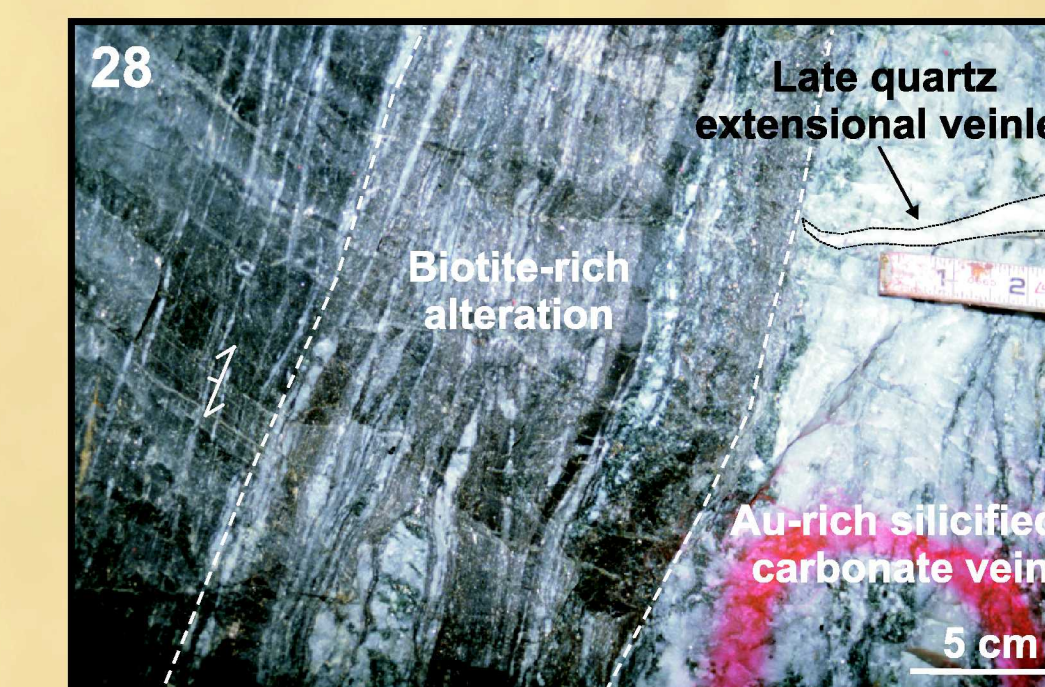
Late remobilisation of gold as shown by abundant visible gold present within both the host basalt and a late lamprophyre dyke. Section view (32-826-1 EDR). (Photograph taken by Goldcorp production staff).



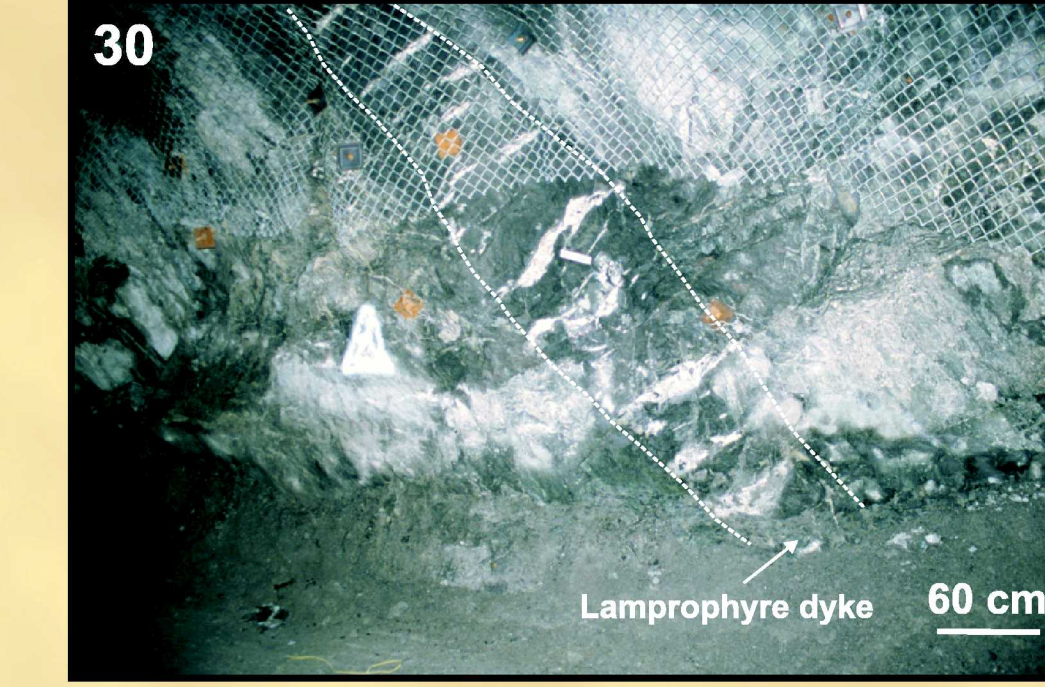
Close-up of the fold hinge shown on figure 23, showing abundant visible gold coating the axial planar cleavage. Scale is in millimeters. GSC 2001-020V.



Isoclinally folded quartz-sulfide vein in the footwall of the hangingwall shear. Section view (34-806-2 WDR). GSC 2001-020X.



$S_2$ -parallel Au-rich silicified carbonate vein in the high strain HW shear with strongly foliated biotite alteration selvages. Section view (34-806-4 WDR). GSC 2001-020Z.



Lamprophyre dyke crosscut by late sigmoidal extensional barren quartz veins. Sigmoidal vein geometry suggests a vertical component of displacement along the dyke. Section view (stope 32-786-8 WDR). GSC 2001-020BB.

**\*This Photographic Atlas complements a paper published by Dubé et al., 2001**

Dubé, B., Williamson, K., and Malo, M., 2001. Preliminary report on the geology and controlling parameters. The GOLDCORP Inc. High Grade Zone, Red Lake Mine, Ontario. Geological Survey of Canada, Current Research 2001-C18, 13p.

Available in Canada from the Geological Survey of Canada Bookstore website at: <http://www.nrcan.gc.ca/gsc/bookstore>.

The world class Campbell-Red Lake deposit being actively mined by Placer Dome (Campbell Mine) and Goldcorp (Red Lake Mine), is one of the largest and richest Canadian Archean gold deposit (>18 M oz Au). It represents a very attractive style of mineralization due to its exceptionally high average grade (21 g/t Au). The Goldcorp High-Grade zone (HGZ) at the Red Lake Mine has in reserves (proven and probable) 1.696 M tons at an average grade of 47 g/t Au (Goldcorp 1999 annual report) and constitutes an excellent example of such high-grade ore. The association of axial planar carbonate veins, high-grade ore zones and  $F_2$  fold hinge deforming the basalt-ultramafic contact in the Goldcorp High Grade Zone suggests a local geological control by an  $F_2$  fold. The development of such  $F_2$  fold was potentially critical in forming the structures hosting the veins and in controlling fluid circulation allowing formation of the carbonate extensional veins (photos 3-7) within the basalt and their subsequent Au-rich silicic replacement.

The  $CO_2$ -rich and the auriferous silica-rich fluids were preferentially focused in a low pressure  $F_2$  hinge deforming the basalt-ultramafic contact due to a combination of factors including competence contrast, tangential longitudinal strain associated with  $F_2$  and ESE-trending  $D_2$  high strain zones. The altered ultramafic (photo 8) acted as a less permeable barrier controlling fluid migration along the folded contact, allowing supralithostatic fluid pressure to build up and inducing a ponding effect in the basalt underneath, to create wide high grade ore in low pressure hinges. The carbonate veins represent a first hydrothermal "ground preparation" stage for the following, and syn- to late- $D_2$ , Au-rich silicic replacement (photos 10-16). The gold-bearing silicic replacement is syn- to late-asymmetric boudinage of the barren carbonate veins (photos 9-14). The High Grade Zone mineralization (photos 17-21) is cross-cut by unaltered late- $D_2$  feldspar porphyry dikes (photo 29), themselves cut by lamprophyre dikes. Subsequent strain and metamorphism

remobilized gold in late extremely high grade structures after the emplacement of the steeply dipping lamprophyre dikes (photos 22 and 30). At the deposit scale, the Campbell and Dickinson faults have played a fundamental role in the formation of the Campbell-Red Lake deposit by controlling vein geometry and fluid access. At stope scale, the combination of multiple hydrothermal events, several strain increments with gold deposited and remobilized in the low pressure hinge zones of the  $F_2$  fold, is responsible for the exceptionally rich ore of the High-Grade Zone and the Campbell-Red Lake deposit. Two important exploration implications for the Red Lake district are: 1- the  $F_2$  hinge deforming the basalt-komatiites contact represent the best target for High-Grade gold mineralization; 2- the amphibolite rocks can be prospective for high-grade gold mineralization.

Graphic Design: Kenneth Williamson & Gilberto Rancourt