Structural evolution of the Ketza River gold deposit

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Abstract

Two phases of ductile deformation, followed by thrusting and extension, affected the Ketza River Mine area. D1 produced large scale E-W trending folds (F1) with upright axial planes, and a pronounced axial planar foliation (S1). Large scale F2 folds have E-W axial trends coincident with those of F1, and moderately NNE-dipping axial planes and axial planar foliation (S2). D2 also produced small-scale, SSW-verging folding of S1 along E-W to NW trending axes.

Shallowly SSW-dipping thrust fault surfaces, and regional analogies suggest NE-directed thrusting (D3). An extensional event (D4) coincided with the timing of mineralization. Normal displacement along the S-dipping Peel Fault resulted in the separation of the map area into two stratigraphic domains: predominantly unit 1a argillites exposed in the northern domain, and predominantly unit 1d limestones exposed on the southern domain. Subsequent to the development of the Peel Fault, a series of NNW trending listric and planar normal faults separated the map area into four structural domains: 1) western half-graben; 2) central horst,; 3) eastern graben; 4) eastern planar high-angle fault blocks. Axial-planar extensional veins developed along drag folds associated with graben-forming faults are intimately associated with manto-style orebodies. Several orebodies extend from listric normal faults in the preferentially mineralized limestone facies, suggesting that D4 faults were primary conduits for mineralizing fluids. There is no regional equivalent of D4. D4 may represent brittle response to the emplacement of a pluton.

The last deformation event (D5) produced a reverse fault that conceals the eastern portion of the Peel Fault (D4). D5 was a local, post-mineralization event that produced little dismemberment of the orebodies.

Résumé

Deux phases de déformation ductile, de chevauchement, de distension et de formation de failles inverses ont touché la région de la mine de Ketza River. D1 a engendré des plis de direction E- W à grande échelle (F1) à plans axiaux droits et une foliation (S1) planaire axiale prononcée. Des plis F2 à grande échelle se caractérisent par des directions axiales E-W coïncidant avec celles de F1 et par des plans axiaux et des foliations (S2) planaires axiales à pendage modéré vers le NNE. D2 a également engendré un plissement de S1 à vergence SSW à petite échelle le long d'axes de direction E-W à NW. D3 est un épisode de chevauchement. La présence de surfaces de chevauchement à faible pendage vers le SSW ainsi que des analogies régionales laissent supposer qu'il y a eu chevauchement vers le NE.

D4 est un épisode de distension contemporain de la minéralisation. Le déplacement normal le long de la faille Peel, à pendage vers le sud, s'est traduit par la séparation de la région cartographique en deux domaines stratigraphiques : un domaine nord où affleure principalement l'unité 1a d'argilite, et un domaine sud où affleure surtout l'unité 1d de calcaire. Postérieurement à la formation de la faille Peel, une série de failles listriques et normales planaires de direction NNW ont séparé la région cartographique en quatre domaines structuraux : 1) semi-graben occidental; 2) horst central; 3) graben oriental; 4) blocs faillés planaires orientaux à fort pendage. Des filons de distension du type B-C qui se sont formés le long de plis d'entraînement associés à des failles formatrices de grabens sont étroitement associés à des corps minéralisés du type manto. De nombreux corps minéralisés s'étendent à partir de failles listriques normales jusqu'au faciès de calcaires propice à la minéralisation, ce qui suggère que les failles D4 ont constitué des conduits primaires pour les fluides minéralisateurs. Il n'existe pas d'équivalent régional de D4. Il est possible que D4 représente un épisode cassant consécutif à la mise en place d'un pluton.

Le dernier épisode de déformation (D5) a engendré une faille inverse qui masque en la partie occidentale de la faille Peel (D4). D5 a été un épisode local postérieur à la minéralisation qui n'a provoqué qu'une faible dislocation des corps minéralisés.

INTRODUCTION

The Ketza River mine is located in the Pelly Mountains, approximately 40 km south of Ross River and less than 30 km from the Tintina Fault. Regional setting, local geology and mineralogy of the orebodies is summarized in Stroshein (1996). The mine produced over 100 000 ounces of gold between 1988 and 1990, and the mine area (Fig. 1) has been the focus of intensive drilling and geological study since 1994 by YGC Resources Inc. New discoveries added approximately 40 000 tonnes of drill-indicated oxide reserves grading 10.1 g/t Au. The drilling also discovered as-yet-undefined oxide reserves containing gold grades between 7 and 16 g/t. A target of 100 000 tonnes of oxide reserves is the objective to initiate a feasibility study of mining and trucking the ore to a large-area mill. Current resources of oxide ore are estimated at 60 000 tonnes (R. Stroshein, pers. comm., 1997).

Early Cambrian limestones (unit 1d) that form the southern half of the mine area are host to Au-rich manto-style massive sulphide orebodies, associated Au-rich magnetite-skarns, and Au-rich oxidized orebodies. The subdivision of unit 1d limestone into six mappable facies (Fig. 2; Stroshein, 1997) allows for stratigraphic and structural correlations, and is the key to predicting the location of additional orebodies.

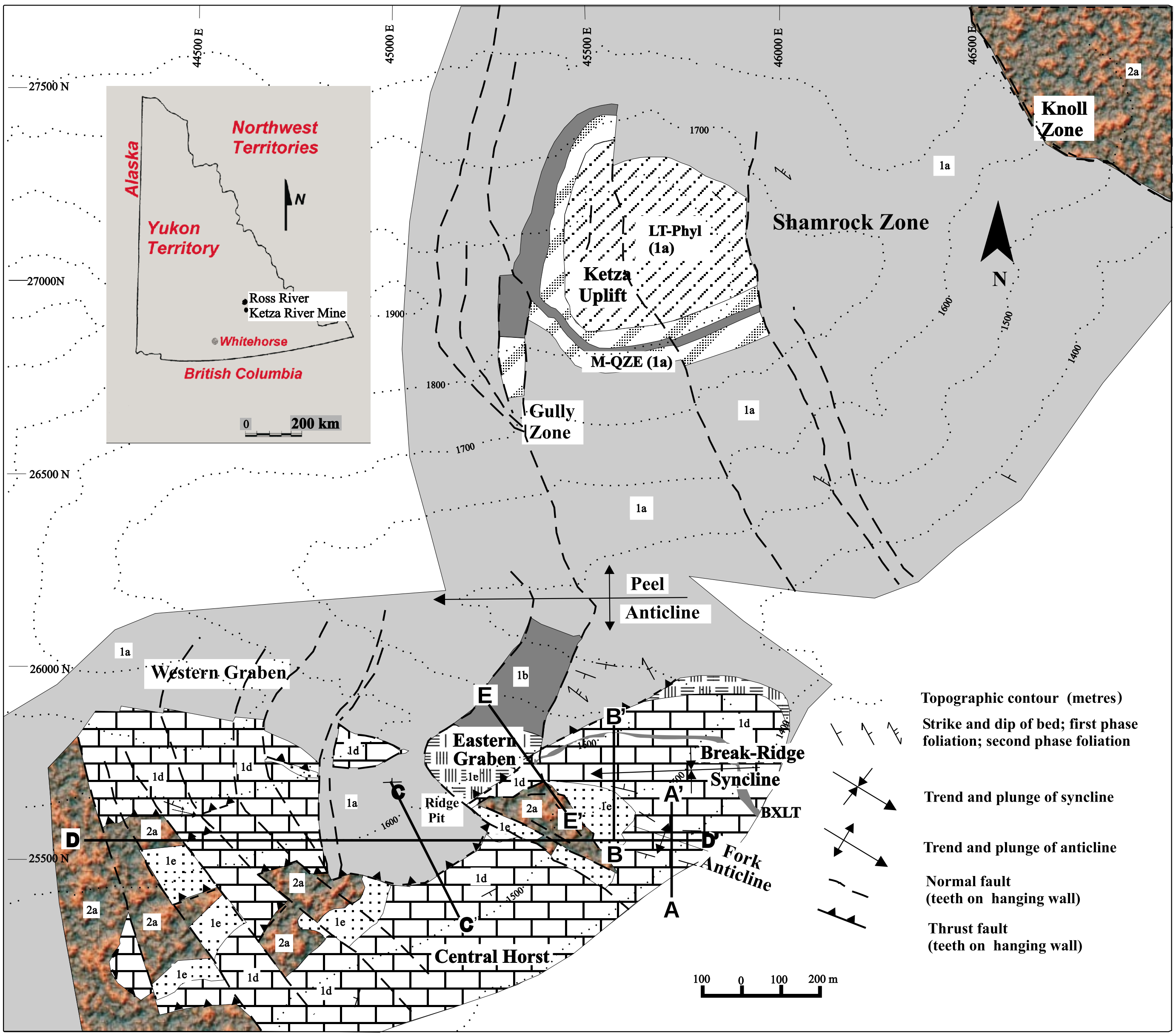

Figure 1. Generalized geology and location of structures on the Ketza River property. Map units are summarized on Figure 2, and cross sections A-E are depicted in Figures 4-8.

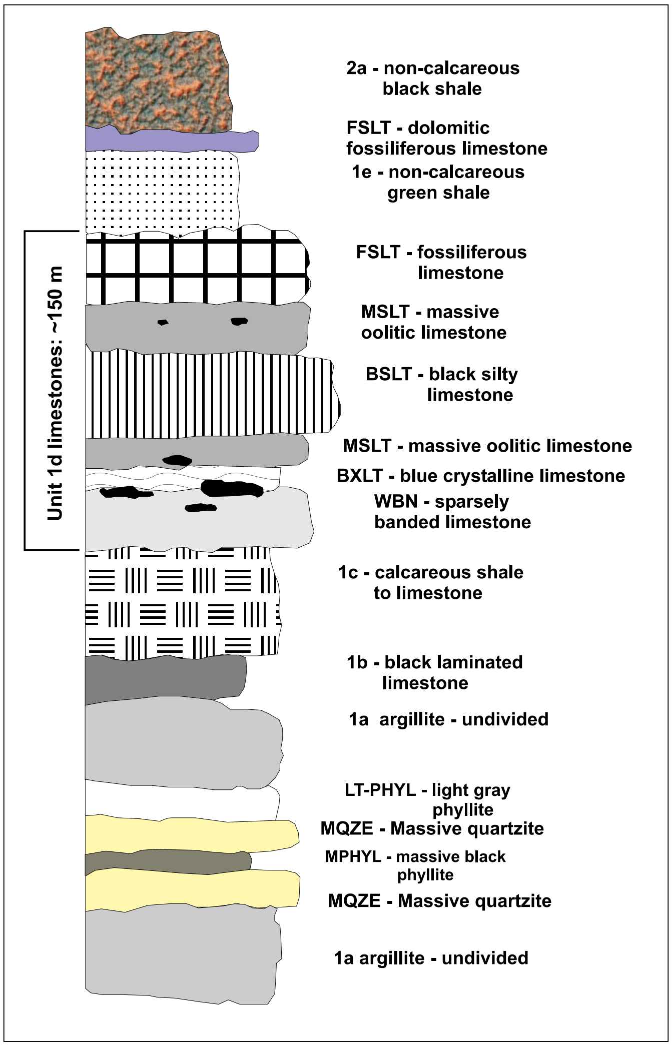

***Figure 2.** Schematic stratigraphic column for the Ketza River mine area.*

The northern half of the map area, known as the "Shamrock Zone" (Fig. 3) is underlain by Late Proterozoic to Early Cambrian argillites (unit 1a). This thick and monotonous stratigraphic package, superimposed by an elongated, >1 g/t Au-in-soil geochemical anomaly more than 1.9 km long, make the Shamrock Zone a promising, yet challenging exploration target for disseminated gold.

The source for mineralizing fluids in the Ketza River Mine area is a subject of debate. Mississippian volcanics and intrusives are the only igneous rocks exposed in the area, and show no spatial relationship to the orebodies. An intrusion, such as a buried pluton of the Cassiar suite, is a likely heat source to drive the hydrothermal system.

DEFORMATION HISTORY

The first deformation event (D1) produced two large-scale anticlines with E-W trending axes (A1 on Fig. 4), upright axial planes, and a well developed axial planar foliation (S1). Figure 4 shows a first phase fold developed entirely in unit 1d limestones. Because the limestones have little detrital component, no axial planar foliation is developed.

The second deformation event (D2) produced: large-scale non-cylindrical folds with E-W trending axes (A2 on Fig. 5) and moderately NNE dipping axial planes, a well developed axial planar foliation (S2), crenulation of S1 in meta-pelitic rocks, and formation of stylolites in limestones. Permeability of the limestone host rock was enhanced along second-phase hinges. Small-scale second phase folds are intrafolial, have NW trending axes (A2), and gently NNE dipping axial planes. A-c veins and joints associated with small-scale second-phase folds served as conduits for later mineralizing fluids. In the meta-pelitic rocks hosting the Shamrock exploration target, carbonate minerals are concentrated along small-scale second-phase hinges.

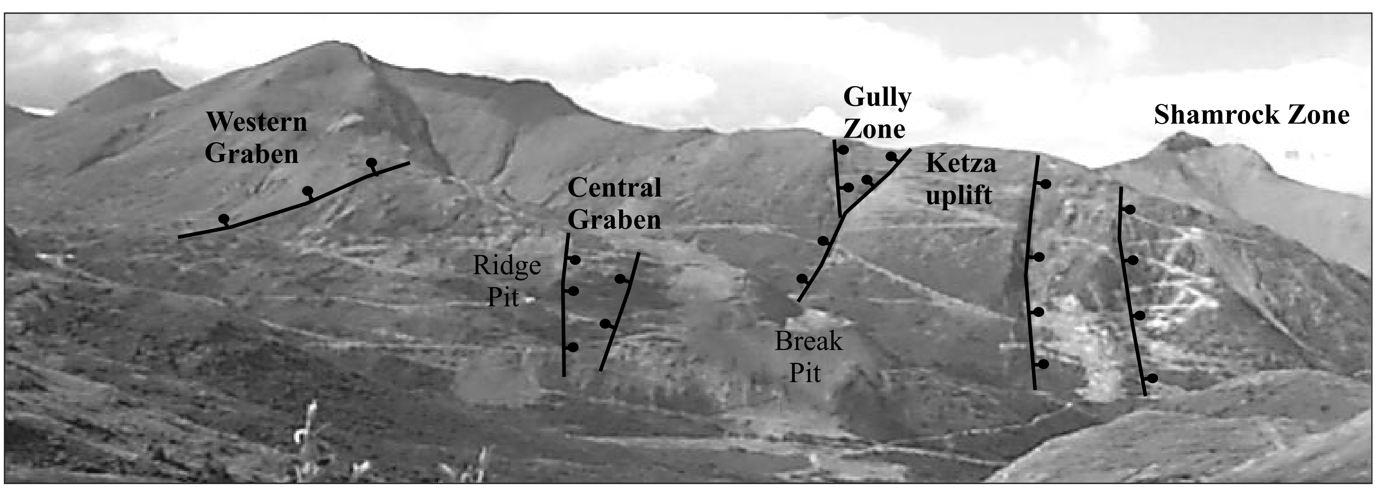

***Figure 3.** Annotated view northward of the Ketza River mine area showing the NNW-striking normal faults, several open pits and mineralized zones.*

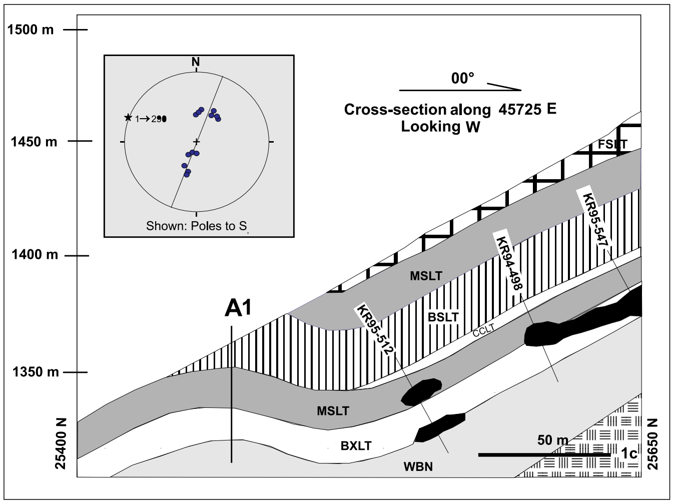

Figure 4. *Cross-section A-A′. The Fork anticline is a first phase fold developed entirely in unit 1d limestones. Black areas are known ore bodies.*

The third deformation event (D3) was also compressional. In the south-central part of the map area a D3 thrust contact between units 1a and 1d (Fig. 6) involved over 850 m of inferred NNE-directed transport, and over 350 m stratigraphic throw.

The fourth deformation event (D4) involved tensional brittle deformation and emplacement of hydrothermal solutions. The most important structure in the area is a steeply south-dipping fault (the Peel Fault) with over 200 m of normal displacement and stratigraphic throw. It separates the map area into two stratigraphic domains: limestones of unit 1d in the hanging wall (south side), and meta-pelites of unit 1a in the footwall to the north. The Peel Fault is exposed in the face of the Ridge Pit, and in the southwest part of the mine area does not have a surface trace on contemporary maps because it is overthrust.

Subsequent to development of the Peel Fault, the D4 event also resulted in a horst and flanking grabens across the mine area. Four structural domains are thereby distinguished (Fig. 7):

a) The Western half-graben is characterized by high-angle listric faults with normal and right lateral displacement. Normal fault blocks displace at least three D3 thrust plates.

b) A Central horst is delineated by a listric normal fault to the West, and a more planar normal fault to the East. The Central horst hosts the largest massive sulphide manto-style orebodies.

c) The Eastern graben extends from the southern to the northern ends of the map area. On the hanging wall of the Peel Fault, it down-drops rocks of units 2a and 1e into direct contact with rocks of unit 1d. On the footwall of the Peel Fault, it down-drops rocks of units 1b and 1c into fault contact with unit 1a. The Gully Zone (Figs. 1 and 3) is a topographic expression of the Eastern graben.

d) High-angle, planar, normal-fault blocks on the northeastern portion of the map area have increasing amounts of down-drop towards NE. Only the Western-most fault block is exposed in the southern portion of the map area. It is the most uplifted block within the limestone domain, and hosts the bulk of the Ketza River manto-style oxide orebodies. In the Shamrock Zone, at least three other normal fault blocks are exposed. The eastern-most and most down-dropped block contains manto-style oxide orebodies hosted by unit 2a limestones.

The last deformation event mapped in the Ketza River mine area (D5) produced one high-angle reverse fault that conceals the eastern and central portions of the Peel Fault (Fig. 8). The amount of reverse displacement along the fault cannot be estimated because marker beds are lacking in the footwall, and the drill hole grid is sparse in the fault area. The D5 fault cuts off oxide orebodies on the upper limb of the D2 Break-Ridge syncline.

STRUCTURAL CONTROLS ON MINERALIZATION

D4 faults served as primary conduits for mineralizing fluids. In the southern, limestone domain, mineralizing fluids ascended along D4 normal faults, and spread laterally through microfissures replacing the most porous limestone facies in the hanging wall.

D3 thrust plates, where preserved, capped the massive sulphide manto-style orebodies and stopped the flow of meteoric water, preventing oxidation. Oxide orebodies are located in the eastern portion of the limestone domain, where D3 thrust plates were eroded.

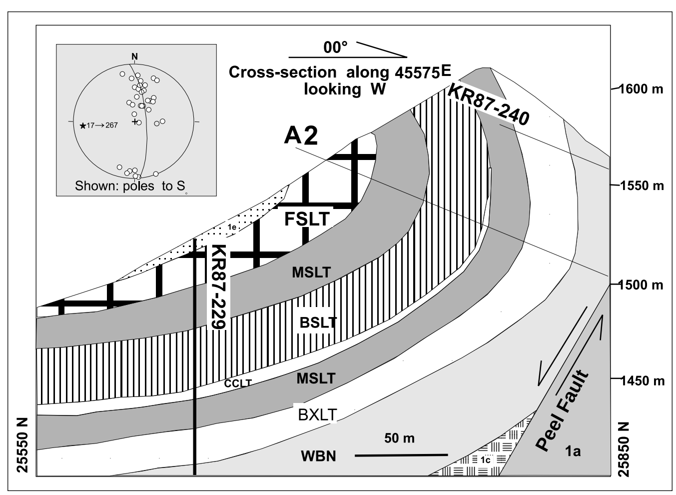

Figure 5. *Cross-section B-B′. The Break-Ridge syncline is a large-scale, SSW-verging fold that developed predominantly in unit 1d limestone. The syncline is cored by pelitic rocks of unit 1e, where an S2 foliation is well developed.*

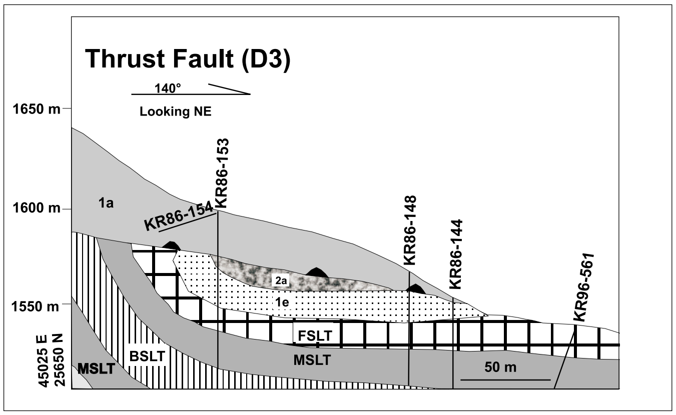

Figure 6. *Cross-section C-C′. Weakly SSW-dipping thrust contact with metapelites of unit 1a cross-cutting an F2 fold in younger units.*

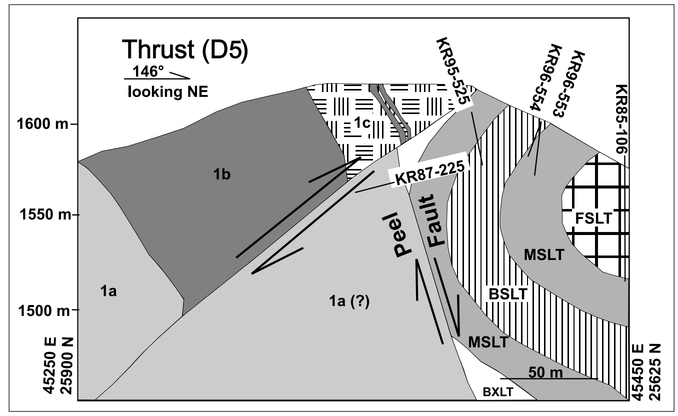

Figure 8. *Cross-section E-E′. The single D5 thrust fault covers the surface trace of the Peel Fault, and truncates the oxide orebodies in the upper limb of a D2 syncline.*

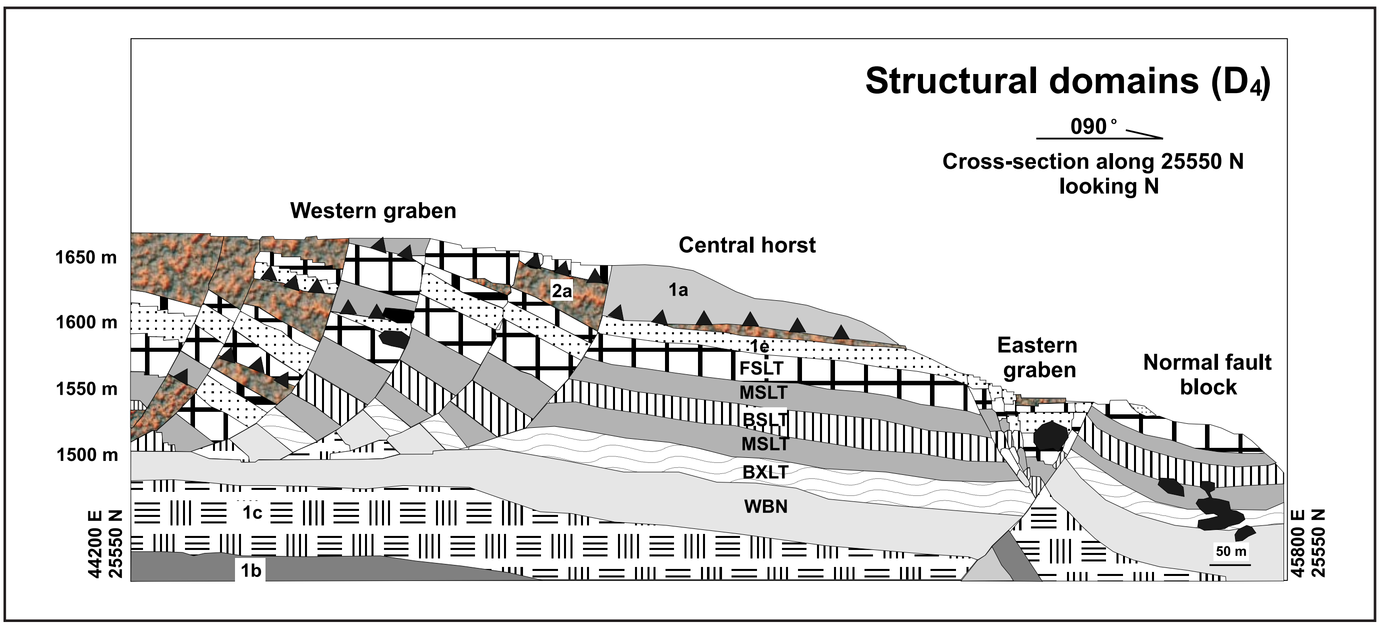

Figure 7. *Cross-section D-D′. D4 listric and listric-planar normal faults separate the map area into four structural domains.*

In the Shamrock Zone ascending mineralizing fluids intruded D4 faults and syn-D2 a-c joints. Where D4 faults intersect permeable, calcareous units are the most favourable sites for disseminated Au mineralization.

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