Structural Controls on Gold Deposits in the La Ronge Domain, Saskatchewan: A Progress Report

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Detailed investigation of controls on gold mineralization in the northern part of the La Ronge Domain, in particular the deposits of the Star Lake and Island Lake Plutons, was undertaken this summer. Previous investigations (Poulsen, 1985, 1986a,b, 1987) provide useful summaries of the concepts of structural geology as applied to ore genesis in this region.

1. Star Lake and Island Lake Plutons

The geology of the Star Lake Pluton is described by Poulsen *et al.* (1986a,b) and Thomas (1985). The pluton covers an area of approximately 14 km^2, and is elliptical in plan, with the longer axis trending north-northeast. The igneous rocks of the pluton are coarse to medium grained, with a zonation from dioritic rocks at the margin, through quartz monzonite to a granitic core. The Island Lake Pluton has an areal extent of 24 km^2, and is south of, and in faulted contact with, the Star Lake Pluton. Thomas (1985) describes the pluton as being of comparatively uniform composition, typically biotite leucogranite, but with minor monzonite to quartz monzodiorite.

a) Structural Geology

Most of the structural data in this report are from the Star Lake Pluton. There are two principal aspects to the structural geology of the pluton: 1) the regional fabric of the pluton (the S1 foliation of Poulsen *et al.*, 1986b) and associated lineation and 2) the shear zones that host the gold deposits.

Regional fabric (S foliation):

The foliation varies in intensity from weak to moderately strong. It is defined by the preferred orientation of biotite (after hornblende), and to a lesser extent by lens-shaped feldspar grains and aggregates. Within the foliation, the long axes of aggregates of biotite grains define a lineation that plunges down dip. Consequently, and particularly where strain is weak, the lineation-foliation fabric may be difficult to see on horizontal surfaces, but is quite obvious on vertical surfaces.

Foliations with the above characteristics typically occur with at least two distinct attitudes. Thus the attitude of the foliation may change across an outcrop, or the two attitudes may be represented by cross-cutting foliations in which one direction is dominant (Figure 1). In either case it is generally not possible to determine the age relationships of the foliations. The intensity of the foliation may increase to form localized zones of high strain, up to 10 cm wide and with strike lengths up to 2 m. C-S fabrics present in some of the local high strain zones indicate that the strain is rotational, and provide information on the sense of slip (Figures 2 and 3).

A further characteristic of the deformation associated with the S1 foliation, is the local development of tabular zones of fine-grained cataclastic material (Figure 3). The zones, typically up to 3 cm wide and 30 cm long, form discrete entities parallel or subparallel to the foliation. Occurring rarely, 0.5 m wide bands of interlayered cataclastic material and foliated rock.

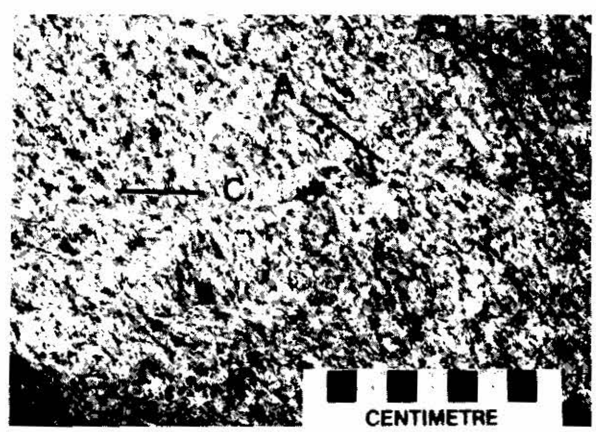

Figure 1 – The photograph illustrates the nature of the foliation in the Star Lake Pluton. The dominant foliation (A) strikes between 020° and 035° and dips steeply northwest. Foliation (B) strikes between 055° and 060° and dips steeply northwest. Foliation (C) strikes 180° to 185° and dips steeply east.

The field data on the S1 foliation and the data from oriented specimens has not yet been completely analysed. The approximate attitudes of the foliation groups that have been identified thus far are as follows: (1) strike 020°, dip 60° NW; (2) strike 050°, dip 75° NW; (3) strike 164°, dip 80° E. The minor shear structures as-

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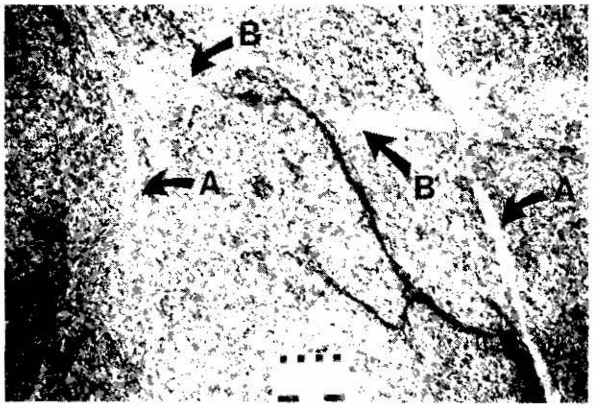

Figure 2 - Star Lake Pluton The small dextral shear (A) strikes 040° and dips northwest at 65°. The shear at (B) trending 150° is sinistral. Both structures contain quartz feldspar vein material. Foliation is approximately parallel to shear (A).

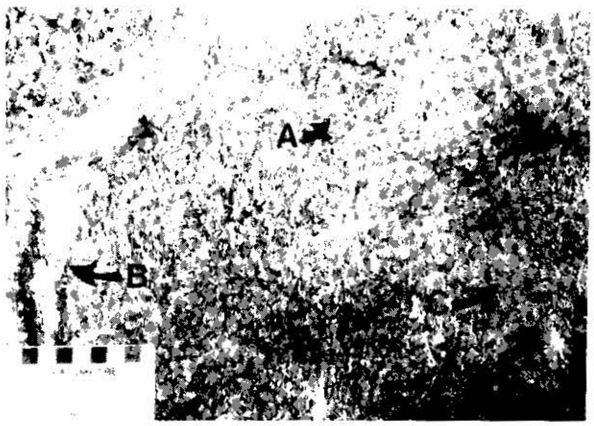

Figure 3 - Star Lake Pluton; diorite The photograph illustrates a narrow shear at (A) (strike: 052°; dip: 60° NW), which displaces a sinistral shear (B) (strike: 162°; dip: 50°). The (B) shear contains quartz feldspar vein material. (C) is cataclastic material in a tabular body, subparallel to (B). The dominant foliation is parallel to the shear direction of (B).

sociated with foliation directions (1) and (2) are dextral, and those with foliations (3) and (4) are sinistral.

Shear Zones and Gold Mineralization:

Gold mineralization in the Star Lake Pluton has been shown by Poulsen *et al.* (1986b) to be related to ductile mylonitic shear zones that typically strike at 060° degrees and dip steeply northwest. The shear zones are up to 30 m wide and at least one shear (the Star Lake Shear) has been traced completely across the pluton. Seven shears have been identified, six of which host gold mineralization. The Star Lake mine closed down in 1989, and presently the Jolu mine is the only producer.

The shear zones contain the same lineation that is associated with regional deformation, but it is more strongly developed. The lineation occurs at the intersections of foliations in the shear zone, and is parallel to the axes of folded, narrow aplite dykes in the shear zone. Figure 4 is a stereographic plot of poles to the foliations and shear planes in a section of the Rod Shear, exposed for a strike length of 65 m, approximately 1 km northeast of the Jolu mine. The poles provide an estimate of the line of intersection of the planar structures. The line of intersection plunges steeply north-northeast. The direction of shearing is subhorizontal and perpendicular to the lineation defined by the biotite and aggregates of biotite grains. The sense of movement is dextral, as noted by Poulsen *et al.* (1986b).

Quartz veins are associated with the shearing described above, and these may be expected to plunge steeply, approximately parallel to the line of intersection of the shear planes and foliations.

The Jolu orebody is a gold-bearing quartz vein deposit in the Rod Shear and in the Rod South Shear which is a splay to the main shear. The veins are confined to the shear zone and have the attitude of P-shears within the

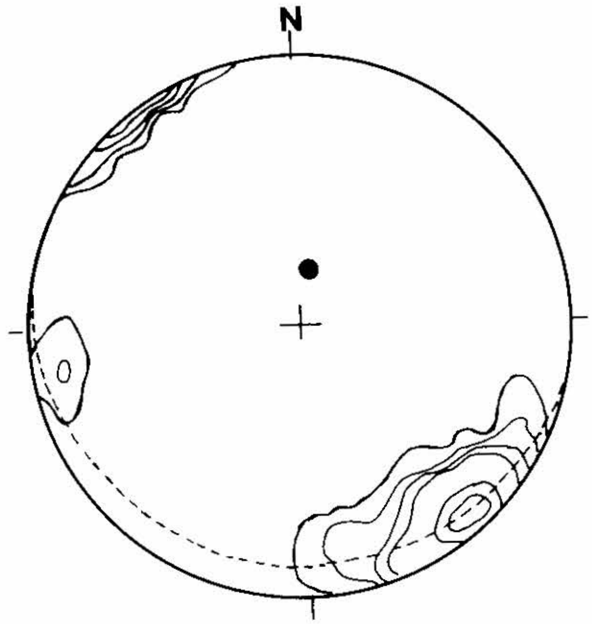

Figure 4 - A stereographic plot of poles to foliations and shears taken from the Rod Shear, approximately 1 km northeast of the Jolu Mine. The poles to the planar structures lie on a great circle; the pole to this great circle plunges steeply north-northeast and approximates the line of intersection of the planar structures. (60 points; contour interval: 4% per 1% area).

narrow shear zone. At the mine, the dip of the northeast-trending shear zone is reversed, and the shear dips subvertically to the southeast. The Jolu orebody plunges to the southwest at 60° which coincides with the plunge of the line of intersection of the Rod Shear with the Rod South Shear, as well as the plunge of minor fold axes within the ore-bearing section of the shear zone (Figures 5 and 6). Thus the direction of shear movement associated with the emplacement of veins at the Jolu mine plunges at 80° NE in the plane of the shear. The sense of movement is dextral, the northwest side of the shear moving down relative to the southeast side.

In summary, the Rod Shear zone is dextral, with the direction of slip being subhorizontal (plunging at approximately 10° SW, but at the Jolu mine, emplacement of the quartz veins is associated with later dextral slip, probably confined to the central part of the shear, in a direction which plunges northeast at 30°. The younger, vein-bearing strain regime, is enclosed in the older strain regime.

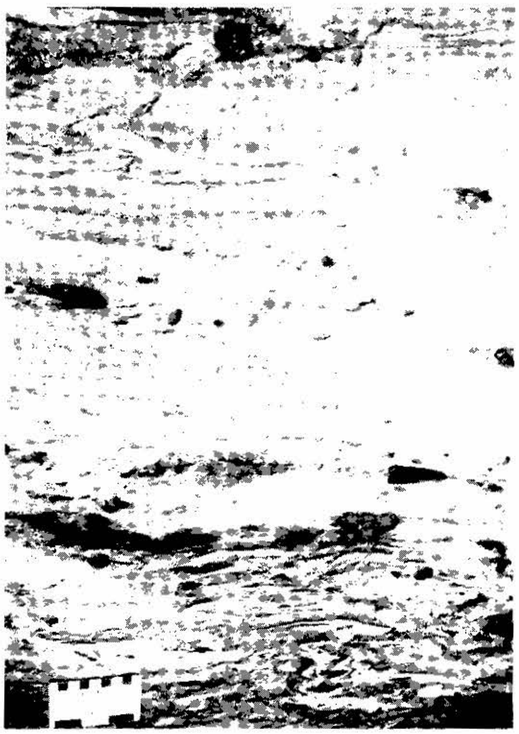

Figure 5 - The Rod Shear at the Jolu mine. The minor folds in narrow aplite dykes plunge 60° southwest.

2. Island Lake Pluton

Data on the attitude of the fabrics of the Island Lake Pluton were not collected, but it was noted that the form of the foliations, and in particular the occurrence of an associated, subvertical lineation, suggests that the deformation is comparable with that of the Star Lake Pluton. Several showings of shear zone hosted gold deposits have been discovered, of which the most significant is the Jasper deposit, where exploration has advanced to the stage of underground development. At surface, the Jasper orebody is a layered, pyritic, cherty quartz vein system, occupying a ductile shear that strikes approximately 035° with a vertical or steep northwesterly dip. The deposit consists of a number of discrete linear orebodies each raking, within the shear zone, at approximately 80° from the northeast. The map (in pocket) covers the southwest limit of the deposit, as its dimensions are presently understood, and the southwestward continuation of the shear zone and its associated vein system which form the James deposit. The shear zone consists of a system of branching, smaller shears in which the principal vein-hosting shears

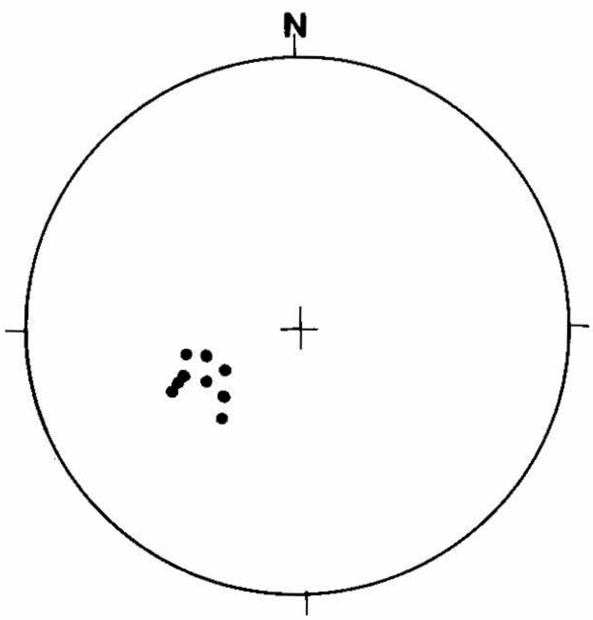

Figure 6 - Stereographic plot of axes to the minor folds shown in Figure 5.

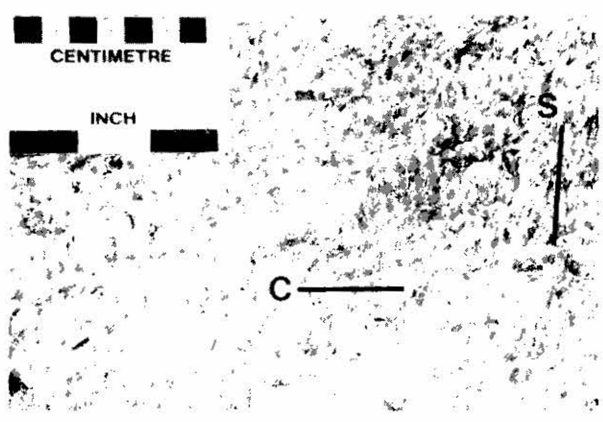

Figure 7 - C-S fabrics in the shear hosting the James-Jasper deposit in the Island Lake Pluton. The C-foliation (plane of shearing) strikes 036° and dips 84° northeast. The intersection of S-foliation with the C-foliation rakes 80° from the northeast. The photograph is taken of a steeply dipping surface, subparallel to the C-foliation. The intersection of C and S with the surface is shown in the photograph, thus demonstrating the steep plunge to the C-S intersection.

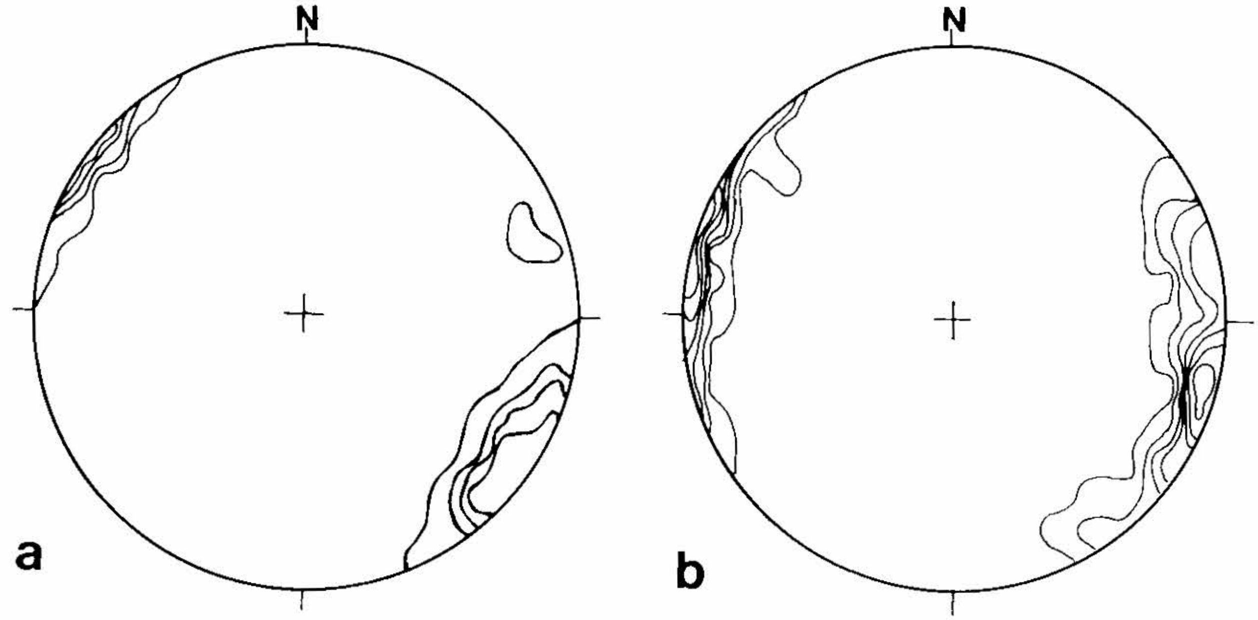

Figure 8 - Stereographic plots for the James deposit, Island Lake Pluton. a) Stereographic projection of poles to shear structures (74 points; contour interval: 4% per 1% area). b) Stereographic projection of poles to quartz veins. (47 points; contour interval: 4% per 1% area).. The poles to the shears and the veins fall on a great circle near the perimeter of the stereonet, reflecting the steep dip of the structures and the near vertical attitude of their line of intersection.

are oblique to the general trend. The C-S fabrics (Figure 7) and the closure of the minor folds shown in the map indicated a right-handed sense of shear movement. Thus the vein-bearing oblique shears have the geometry of P-shears.

The steeply plunging line of intersection of the C-S fabrics in Figure 7 is a very good indication that the sense of movement is horizontal or approximately 30°. The stereographic plot of the poles to the shear structures and the veins (Figures 8a and 8b) fall on a great circle close to the perimeter of the stereonet, which reflects the steep dip of the structures and the steep plunge of their line of intersection. This again is in agreement with strike slip movement of the shear. The linear orebodies that make up the deposit are parallel to the plunge of the line of intersection of the planar structures.

3. Discussion

The following conclusions may be made from this brief examination of the structures and deposits of the Star Lake and Island Lake Plutons.

1) Deformation outside the shear zones involves the development of the same, steeply plunging, northeast lineation that occurs within the shear zones. Furthermore, the planar fabrics indicate that the deformation outside the shear zones involves a component of rotational strain.

2) An analysis of the planar structures (foliations, shear planes and veins) in the shear zones demonstrates that the steep northeast lineation is an intersection lineation, and that shear displacement was primarily strike slip.

3) the plunge of the gold-bearing vein deposits is perpendicular to the direction of shear. This is well demonstrated in the steeply plunging orebodies at the Jasper deposit which are associated with strike slip movement. The same relationship between the geometry of the deposit and shear direction can be recognized at the Jolu mine, but here mineralization is associated with a localized shearing event which post dates the strike slip shearing, and involves a change of the shear direction from a 10° plunge southwest to a 30° plunge northeast. From the description given in Poulsen *et al.* (1986b), it appears that a similar structural setting occurs at the Star Lake mine. These observations are important from the point of view of exploring for ore within the confines of a deposit, but the significance of the later oblique slip movements in terms of exploring for new deposits in the shear zones is difficult to evaluate, since mineralization is also associated with (apparently) earlier strike slip movement.

The coincidence, or approximate coincidence, of an extension lineation with an intersection lineation, as described in this report, is a common occurrence in greenstone belts, and probably in other geological settings. In their earlier reports, Poulsen *et al.* (1986a,b) interpreted the direction of shear in the shear zones as being parallel to the northeast lineation. In their later report, (Poulsen *et al.*, 1987), apparently as a result of work beyond the Star Lake Pluton, they noted that the steeply plunging lineation was not confined to the shear zones, which prompted them to suggest "that the ubiquitous "down-dip" lineations in the Star Lake area are not necessarily diagnostic of slip directions in shear zones but are perhaps the product of a regional extension which was coeval with shear zone development." The observations recorded in this report agree with this statement. In its simplest form, the model of deformation for the Star Lake Pluton involves regional crustal shortening with near vertical extension, as indicated by the regional lineation, coincident with dextral strike slip movement on the 060° shear zones. However, rotational strain is not confined to the 060° shear zones but is represented by minor shears in the regionally deformed rocks. This may have some significance in mineral exploration since mineralization has been found in the Island Lake Pluton in shears striking 035° (Jasper), 010° (Roxy) and 070° (Ross).

4. References

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