Gold in Victoria
The current State of Play

Ross Cayley

Geological Survey of Victoria
Department of Economic Development, Jobs, Transport & Resources
Understanding Victorian gold is a team effort.
Talk Outline

• The size of the prize: how rich is Victoria in gold?

• Mineral Systems Analysis and the gold source – understanding Victorian gold potential by understanding the geology

• How understanding plumbing systems gives regional-scale predictive capacity

• The Lachlan Orocline – extending Victoria’s goldfield terrane
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### Significant Drill Intersections of 2017 to Date

<table>
<thead>
<tr>
<th>rank</th>
<th>country</th>
<th>company</th>
<th>project</th>
<th>intersection</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>🇬🇧</td>
<td>Kirkland Lake Gold Ltd. (TSX, OTCQX)</td>
<td>Fosterville</td>
<td>15.15m @ 1429g/t Au from 345.55m</td>
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<td>2</td>
<td>🇧🇷</td>
<td>Cordoba Minerals Corp. (TSX-V, OTCQX)</td>
<td>San Matias</td>
<td>5.00m @ 800.90g/t Au, 88.63g/t Ag, 3.65% Cu, 8.60% Zn from 112m</td>
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<td>3</td>
<td>🇷🇸</td>
<td>Nevsun Resources Ltd. (TSX, NYSE MKT)</td>
<td>Timok</td>
<td>256.3m @ 6.0% Cu, 3.79g/t Au from 438.8m</td>
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<td>4</td>
<td>🇧🇪</td>
<td>IAMGOLD Corp. (TSX, NYSE)</td>
<td>Saramacca</td>
<td>60.5m @ 40.91g/t Au from 14.5m</td>
</tr>
<tr>
<td>5</td>
<td>🇨🇦</td>
<td>Osisko Mining Inc. (TSX)</td>
<td>Windfall Lake</td>
<td>2.5m @ 936g/t Au from 616.5m</td>
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<td>6</td>
<td>🇲🇽</td>
<td>Leagold Mining Corp. (TSX)</td>
<td>Los Filos</td>
<td>85.90m @ 25.3g/t Au from 585.15m</td>
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<td>7</td>
<td>🇨🇦</td>
<td>UEX Corp. (TSX)</td>
<td>Christie Lake</td>
<td>17.70m @ 11.46% U3O8 from 475.10m</td>
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<td>8</td>
<td>🇺🇸</td>
<td>Paramount Gold Nevada Corp. (NYSE MKT)</td>
<td>Grassy Mountain</td>
<td>43.0m @ 47.51g/t Au, 12.68g/t Ag from 166.12m</td>
</tr>
<tr>
<td>9</td>
<td>🇺🇸</td>
<td>Arizona Mining Inc. (TSX)</td>
<td>Hermosa</td>
<td>159.7m @ 78.69g/t Ag, 6.87% Pb, 8.47% Zn, 0.40% Cu from 542.2m</td>
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Top 3 global drill results (May, 2017)

<table>
<thead>
<tr>
<th>Country</th>
<th>Company</th>
<th>(AuEq.)m</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Kirkland Lake Gold Ltd. (TSX, OTCQX)</td>
<td>6464</td>
</tr>
<tr>
<td>1</td>
<td>16m @ 404g/t Au from 113.2m</td>
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</tr>
<tr>
<td></td>
<td>Osisko Mining Inc. (TSX)</td>
<td>2340</td>
</tr>
<tr>
<td>2</td>
<td>2.5m @ 936g/t Au from 616.5m</td>
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</tr>
<tr>
<td></td>
<td>Silver Standard Resources Inc. (NASDAQ, TSX)</td>
<td>1608</td>
</tr>
<tr>
<td>3</td>
<td>1.6m @ 1004.74g/t Au from 235.2m</td>
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- Total all-time gold mined globally: ~165 000 tonnes *
- Victoria’s recorded gold production (since 1851): ~2500 tonnes+
- 1.5%+ of all the world’s gold, from just 0.15% of global land area
- Victoria’s productive goldfields occupy just 0.03% of global land area

Victoria’s goldfield geology: **2 Orders of Magnitude (100x)** richer in gold than the global average.
Nearly 50% of the surface area of known goldfield geology extends under shallow cover – geophysics demonstrates the connectivity.

~1500+ tonnes Au yet-to-find – but predictive capacity has to grow.

Recent and ongoing successes like Fosterville, Costerfield (and Ararat) show what the brownfields can deliver.
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• The Lachlan Orocline – extending Victoria’s goldfield terrane
The most common host rock for Victoria’s orogenic gold deposits – folded and faulted, quartz-rich deep marine sediments – **not inherently rich in gold**

(Bierlein, 2004)
Possible source of gold:

Cambrian metavolcanics like those exposed in the Moornambool Metamorphic Complex, in the Avoca Fault, and in the Heathcote Fault Zone

(Bierlein, 2004)
Regional deep seismic reflection transects: pmd*crc,
Detail of the Heathcote Fault Zone
Gold-fluids from metavolcanics doesn’t have to be an efficient process.

New work shows thousands of cubic kilometres of potential metavolcanic source rock underlies the goldfields.

The Heathcote Fault is thick-skinned!

Cayley et al., 2011
Line 06GA-V2 - interpretation

Willman et al., 2010

Cayley et al., 2011
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Full-crustal-thickness (40km!) geological model at 1:250 000 scale

Rawling et al., 2012
Full crustal section, Stawell and Bendigo Zones
Inflection-point mapping, using the 3-D model
1500 metre buffer.....around surface fault traces (yellow around red): Captures 41% known Au deposits, 27% intermediate-large size Au deposits

1500 metre buffer.....around inflection point upward projections (green around purple): Captures 67% known Au deposits, 60% intermediate-large size Au deposits + 30% smaller buffer area = Inflection point projections win as a goldfield predictor!
Numerical modelling of crustal-scale deformation.

Eg. Leader & Wilson, 2010
Schaubs et al., 2012

15% shortening
Gale simulations of basin closure

Gale simulations carried out by Guillaume Duclaux – CSIRO
Gale simulations of basin closure

- Initial formation of basin bounding faults
  - Dip towards the basin
  - Moyston and Heathcote
- Subsequent development of back thrusts
  - Dip towards basement blocks
  - High strain zones form with the basin
Recreates large bounding faults and a network of internal faults.

$t = 10 \text{ Ma}$

25% cumulative shortening

Post Failure Strain

$<10\%$  $>15\%$

**Pop-up**

**Intra-basinal faults**

**Border Fault**

**Main basin thrust**
Gale simulations of basin closure

As these models are refined, improved predictive capacity for orogenic gold is sure to follow.....
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Moresi, Betts, Miller & Cayley 2014, NATURE.

Cayley & Musgrave, in review
Moresi, Betts, Miller & Cayley 2014, NATURE.

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Cayley & Musgrave, in prep.
Conclusions

- There is huge upside for Victorian orogenic gold, brownfields and greenfields. Government keen to help (eg. pre-competitive geoscience, TARGET funding, Monash ARC linkage on Orogenic Gold).

- Developing predictive capacity through good science boosts confidence, helps overcome investment notions that Victorian gold is maybe ‘too hard’....

- Good science, good exploration, can find new deposits (eg. Four Eagles), and can help Brownfields deliver (Fosterville, Costerfield, Ararat? Stavely?).

- New understanding (Lachlan Orocline) boosts the prospectivity of overlooked terranes (northern Tabberabbera Zone)

- New understanding of the geodynamic drivers of the system place Victorian orogenic gold into context with adjacent Arc terranes (Macquarie Arc, Stavely Arc) with proven potential for magmatic-related base-metals and gold.