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A1 Project
Brainstorming Session

ARRC, Perth, August 11th, 2004

James Cook University
The University of Western Australia
Monash University
The University of Melbourne
AMIRA International
CSIRO
Australian Government
Geoscience Australia

Today's Agenda & Objectives

- Review outcomes of A1 workshop, May 3-4, 2004
- Database interrogation; Yilgarn faults example
- Distil and prioritise small number of hypotheses
- Define input parameters for modelling scenarios (for output by 04/05)
- *(recommendations for future directions?)*

What we know (or think we know) - potentially critical factors:

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- Long-lived, complex damage zones (kinematic evolution); degree of non-linearity & gradients
- Rheological contrast; strain partitioning
- Steeply-dipping orientation at shallow levels
- Proximity to (ancient) plate margins, sutures
- Presence of mafic - intermediate igneous rocks
- Extensive alteration
- Kinematic evolution
- Length, relay zones, displacement

Interrogation of A1 TT database

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- Number of Faults on the Database: 132
- Number of mineralised Faults: 80 = **60.6%**
- Number of non-mineralised Faults: 52 = **39.4%**
- Number of Faults with all styles of gold mineralisation: 52 = **39.4%** (65%)

Data base interrogation (I)

	mineralised faults	unmineralised faults
Evidence of magmatism along fault	58 (72.5%)	26 (50%)
Presence of ophiolites	8 (10%)	4 (7.7%)
- uncertain	10 (12.5%)	14 (26.9%)
Magmatism associated with Au		
- major felsic/intermediate	38 (70.4%)	
- bimodal	2 (3.7%)	
- no magmatism	14 (25%)	
Source of fluid: magmatic	48 (60%)	1 (2%)
- in gold-mineralised systems	37 (68.5%)	
Geodynamic regime		
-compressional/transpressional	69 (86.3%)	37 (71.2%)
- extensional/transtensional	5 (6.3%)	10 (19.2%)

Data base interrogation (I)

	mineralised faults	unmineralised faults
Geometry of fault		
- listric	34 (42.5%)	17 (32.7%)
- planar	44 (55%)	30 (57.7%)
Rheology		
- brittle-dominated	10 (12%)	15 (28.9%)
- brittle/ductile	70 (87.5%)	33 (63.5%)
Evidence of basin inversion	34 (42.5%)	17 (37.7%)
- unspecified	30 (37.5%	21 (40.4%)
Dip at surface		
- steep (>60°)	46 (57.5%)	36 (69.2%)
- shallow (<60°)	28 (35%)	8 (15.4%)
Fault active: yes	14 (17.5%)	17 (32.7%)

Data base interrogation (I)

	mineralised faults	unmineralised faults
Manifestation at current level		
- **linear**	10 (12.5%)	19 (36.5%)
- **complex**	70 (87.5%)	33 (63.5%)
Associated with current plate boundary	1 (1.3%)	3 (5.8%)
Lateral extent >200 km	19 (23.7%)	19 (36.5%)
Width of corridor		
- <1 km	43 (53.8%)	23 (44.2%)
- 1 - 6 km	27 (33.8%)	14 (26.9%)
- > 6 km	7 (8.8%)	8 (15.4%)
Depth extent > 10 km	45 (56.2%)	33 (63.4%)

Data base interrogation (I)

	mineralised faults	unmineralised faults
Relationship with other faults		
- master structure	22 (27.5%)	21 (40.4%)
- semi-parallel	53 (66.3%)	26 (50%)
- cross-cutting	5 (6.3%)	5 (9.6%)
Linkage of single fault segments		
- continuous	68 (85%)	44 (84.6%)
-discontinuous	12 (15%)	8 (15.4%)
Tectonic setting		
- collisional orogen	48 (60%)	20 (38.5%)
- convergent margin	5 (6.3%)	6 (11.5%)
- intraplate	9 (11.3%)	8 (15.4%)
- other (rift, passive margin)	19 (23.8%)	18 (34.6%)

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Yilgarn Faults Interrogation

(Terry Lees, Frank Bierlein)

A simple test of (potentially) mantle-tapping faults in the Yilgarn, and their significance for gold endowment

Hypothesis:

Mineralisation is associated with faults that intersect(ed) the mantle at the time of mineralisation

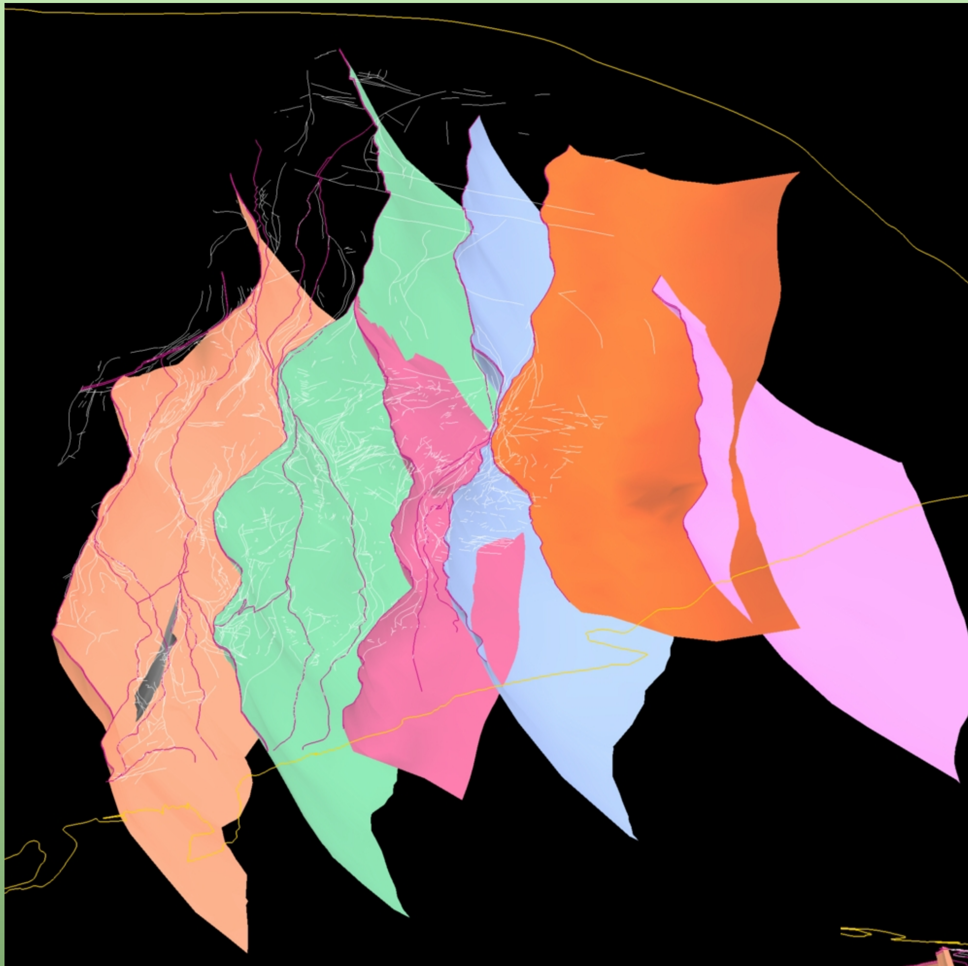
Test: from a subset of the Yilgarn data, select and define faults that intersect the mantle into: DO, DO NOT and UNSURE categories

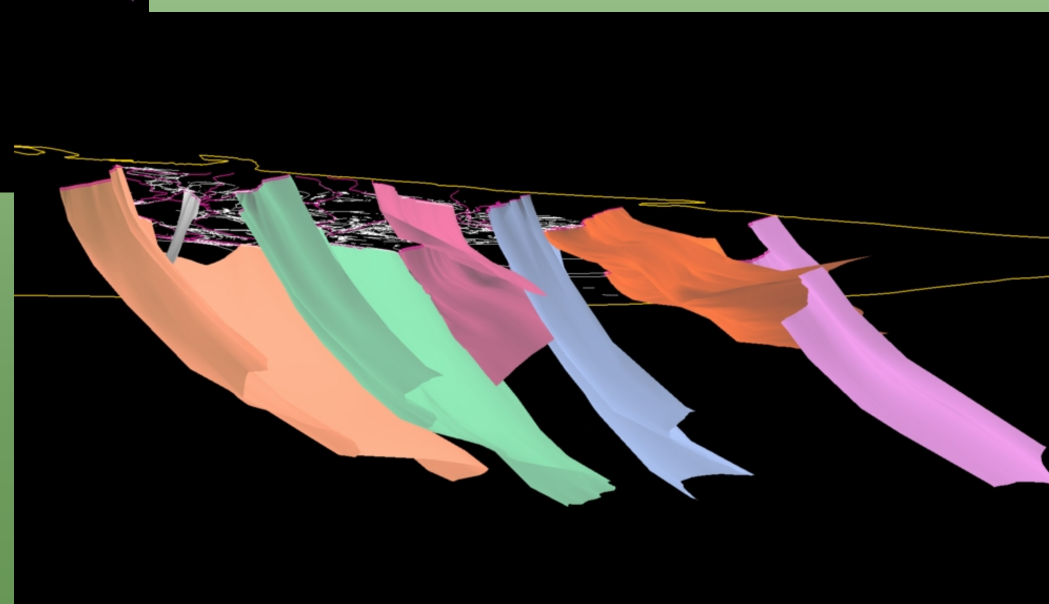
Relate mineralisation contained within buffers around these faults to the categories

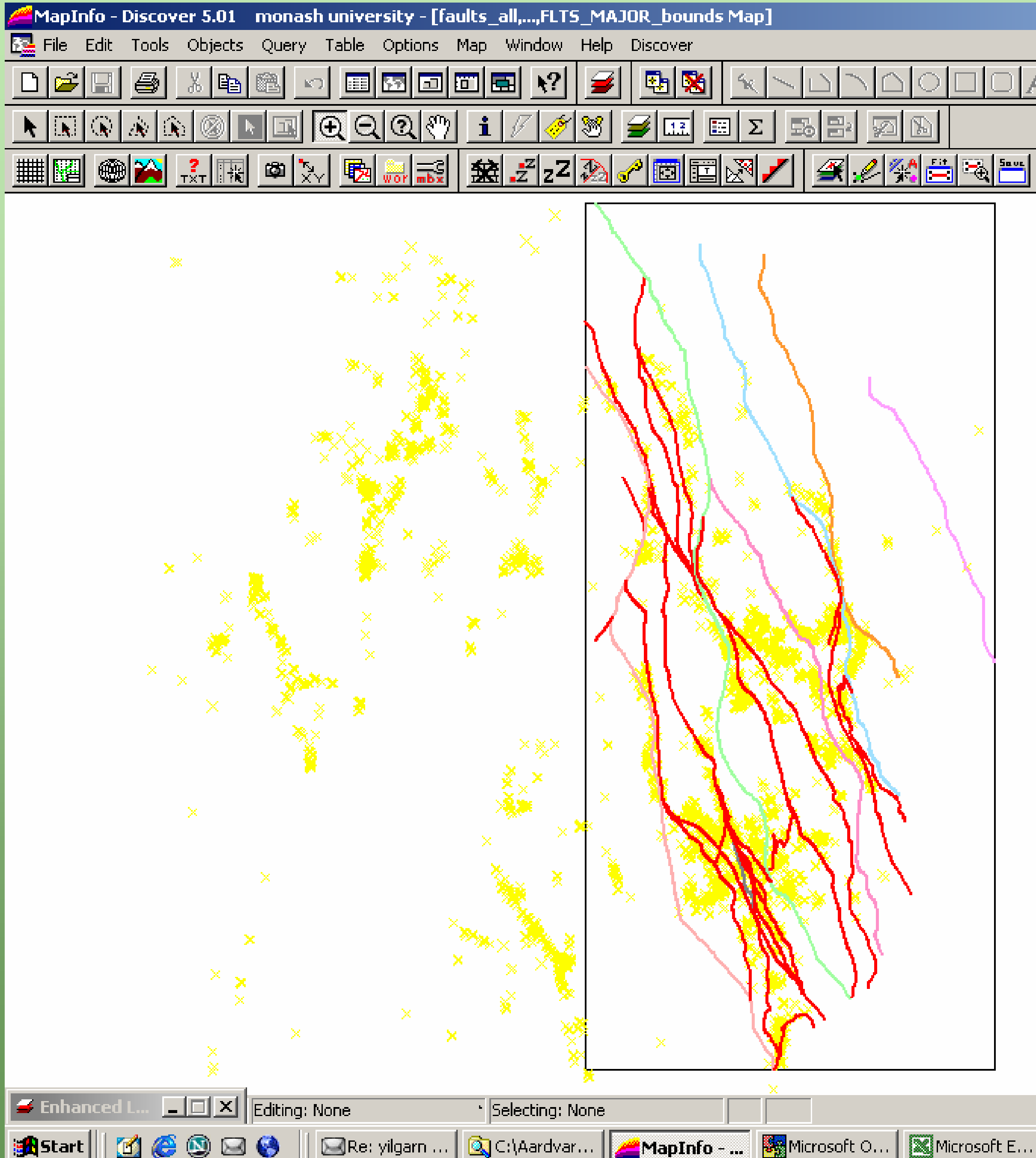
Data and Assumptions

- Fault data set from GA
- Fault categories defined by interpretation of seismic by GA
- Mineralisation data from Minloc and Ozmin, modified and ranked by Lees/Murphy
- Assumed that faults seen now reflect the geometry at time of mineralisation
- Assumed that there are enough data to be meaningful, although only 5 major and 2 splay faults

Yilgarn 3D fault data set
(from Bruce Goleby, GA)

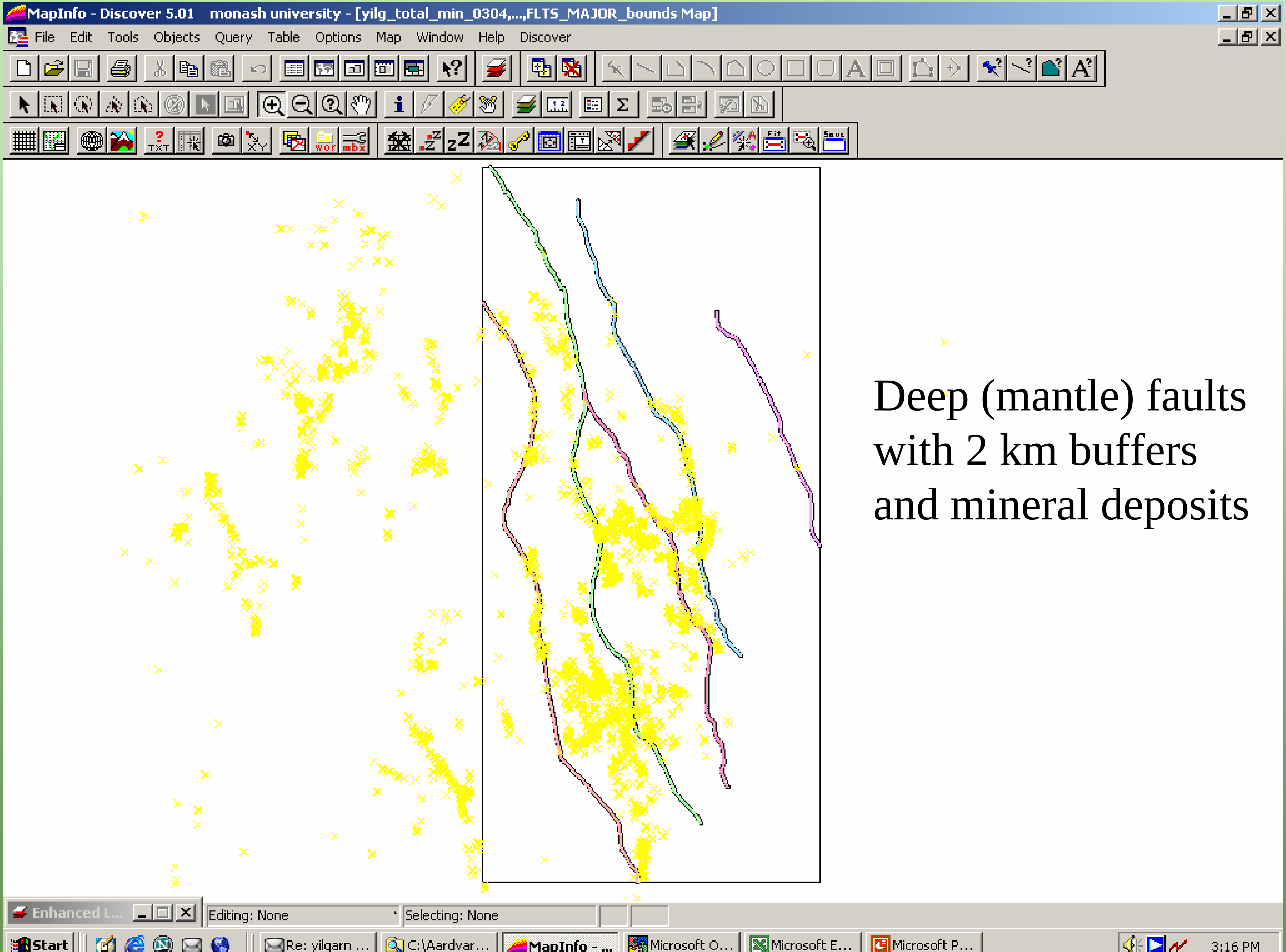




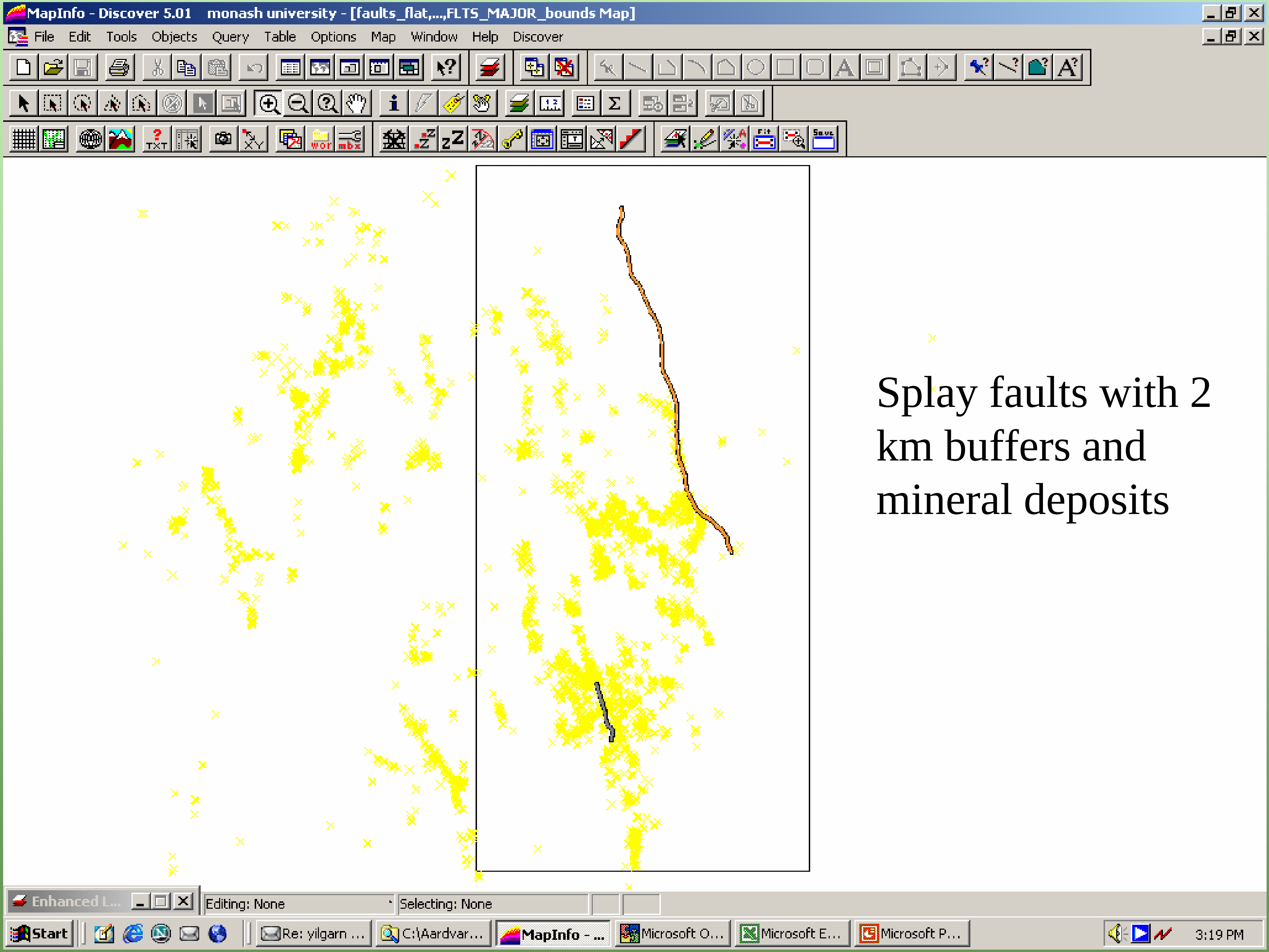


Norseman-Wiluna fault data set and mineral deposits in Mapinfo.

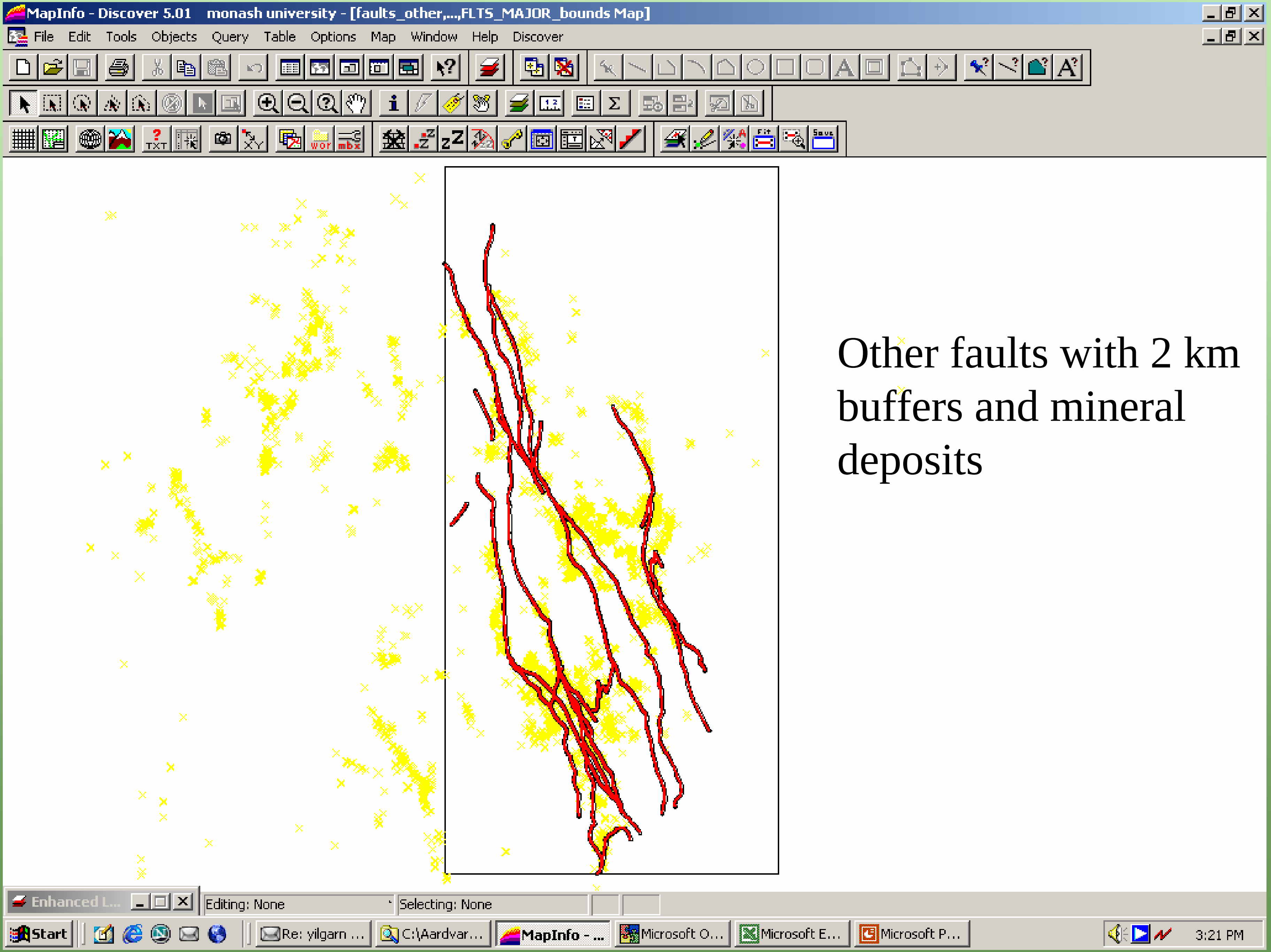
Red are UNSURE; other coloured faults as per 3D image.



Deep (mantle) faults with 2 km buffers and mineral deposits



Splay faults with 2 km buffers and mineral deposits



Other faults with 2 km buffers and mineral deposits

Methodology

• Define faults and 2 and 4 km buffers

• Sum mineralisation (both ranked and production) within buffers, divide by buffer area

Mineral deposit ranking:

1 = < 100kg Au
10 = 100 – 1,000 kg Au
100 = 1,000 – 10,000 kg Au
1000 = 10,000 –100,000 kg Au
10000 = > 100,000 kg Au

Results

	area	sum minz rank	Minz-rank/area	Sum production	Sum prod/area
2km buffer					
splay faults	2103	189	0.09	0	0
major faults	12100	12938	1.07	159050278	13145
other faults	16930	39971	2.36	813161884	48031
4km buffer					
splay faults	4252	511	0.12	1400000	329
major faults	23230	14652	0.63	378773484	16305
other faults	32050	57069	1.78	2736459186	85381

Results

1: Virtually no mineralisation is associated with the splays, despite being located in a heavily endowed area.

2: ‘Other’ faults (UNSURE) are best mineralised. Further definition of these in 3D would be very interesting!

Ought to look at…

(modelling scenarios; future directions?)

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- Roughness of fault (gradients) vs location of deposits (*bends & jog tool*?)
- Convection in plane of fault vs focused upflow in discrete zones (also: down-flow, alteration)
- Role of antiforms & related geometric features
- Model/compare vertical structure to surface vs diffuse damage zone above conduit
- Compare with shallow-dipping structures (~40˚)
- Dislocation of mantle-tappers along ductile layer

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1) <u>Fluid flow along plane of fault</u> versus <u>'chimney' model</u>

Start with generic models (& relate to what we see in rocks!)

Add layers of complexity and *look at*:

- **permeability/porosity (+ changes)**
- **fluid flow (including convection/single-pass?)**
- **orientation/change in far field stress**
- **rheological properties (host rock, complexity; intrusions?)**
- **storage capability/access to reservoir**
- **change dip angle (vertical to <40°)**
- **angle of misplacement/roughness of plane**
- **width and diffuseness of fault plane (along-strike + down-dip variations)**
- ***evolution of processes with time* (i.e., time-dependence)**
- ***alteration patterns* (distribution and variation along plane of fault; chemistry)**
  e.g., silica vs carbonate alteration

2) Model/compare vertical structure to surface vs diffuse damage zone above conduit

3) Role of antiforms & related geometric features
- **geometry/architecture**
- **dome beneath seal; shortening -> dilation, fluid flow**

-- **major structure required**

-- **differential uplift (T gradient)**

4) Convection (upflow/downflow geom., distrb.)

5) evolution/transition from compression to transpressional deformation
- timing/extent/component required?
(to be considered/modeled as part of Ynew project?)

6) Integration of/with existing data sets (eg, JGS data; GA; Placer; ongoing M project work)