

An aerial photograph of a university campus, likely the University of Utah, showing a large stadium with a green field and a large crowd of spectators. The stadium is surrounded by various buildings, including dormitories and academic buildings, and is situated on a hillside. The text "U3A Photogeology" is overlaid in yellow on the image.

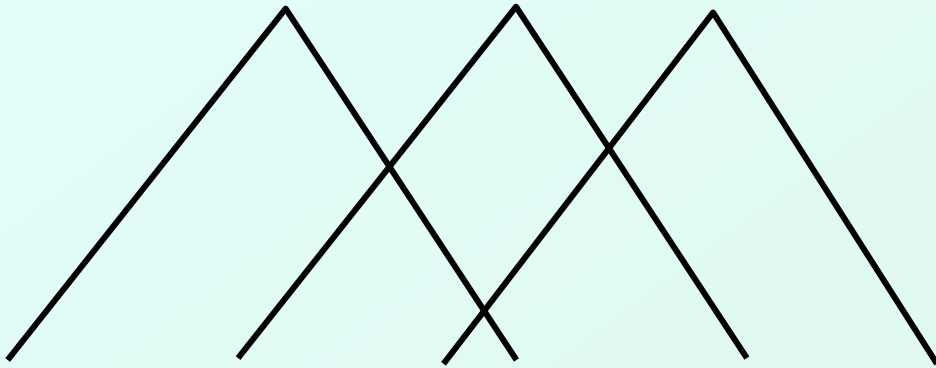
U3A Photogeology

Photogeology

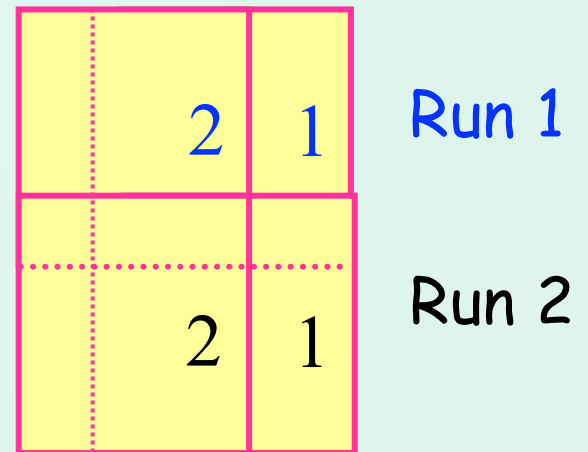
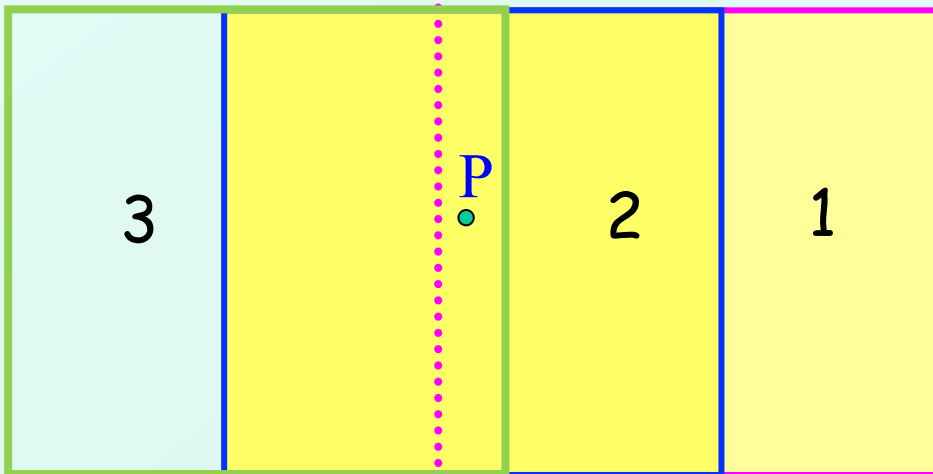
- Form of remote sensing using aerial photographs
- first used in WW1 for identifying enemy troop positions
- highly refined during WW2 for selecting bombing targets
- provides a means for interpreting the geology of large areas (especially remote areas)
- plays a significant role in the process of identifying geological features prior to map preparation
- single photographs enable simple geological interpretation
- overlapping aerial photographs → stereographic vision → show topography → enable more detailed interpretation

Photo surveys

3 ← 2 ← 1



- Undertaken by aircraft along series of parallel lines (runs)
- cameras point down vertically
- every point on the ground appears in at least 2 photos
- usually taken with 60% overlap



Scale determination

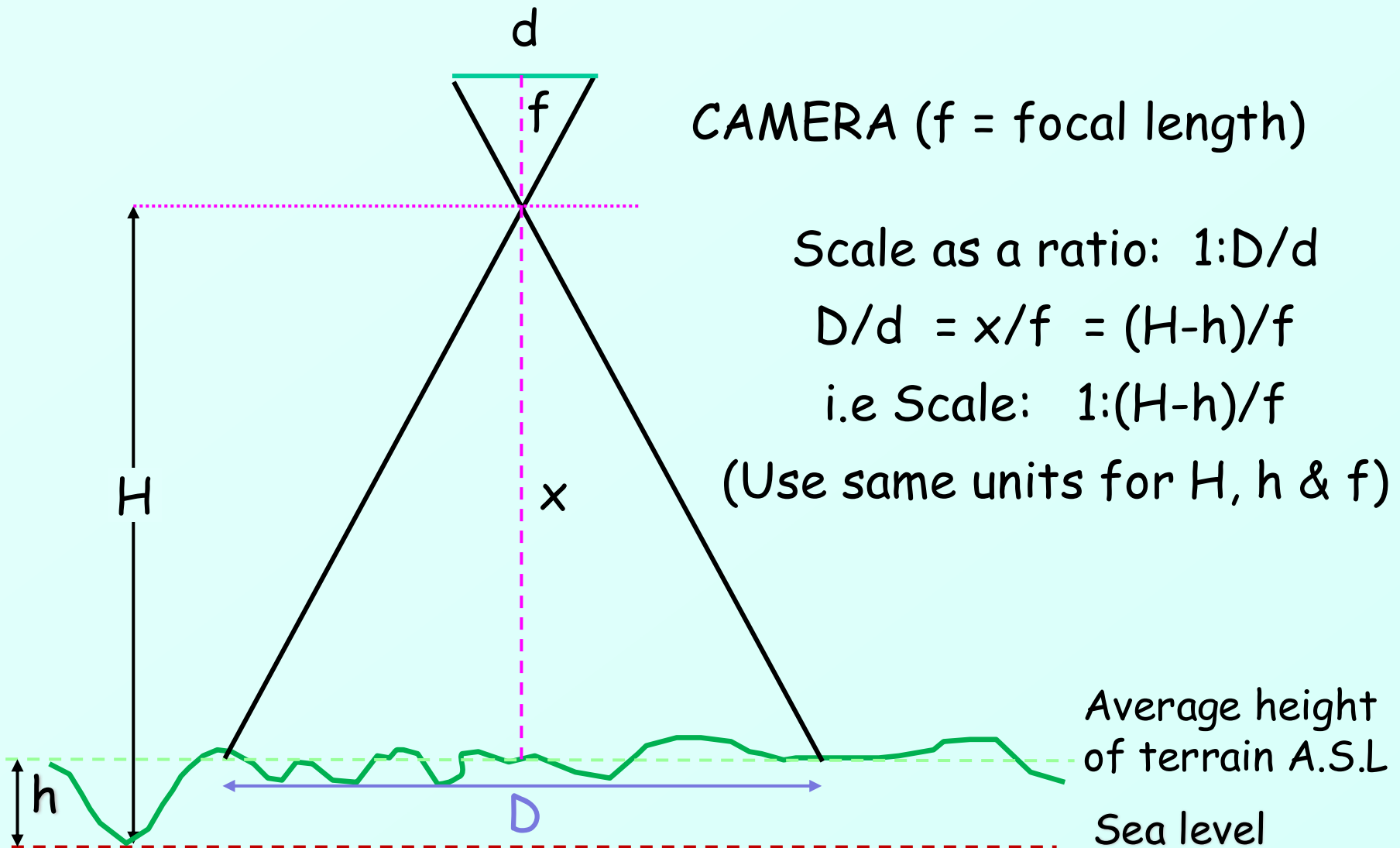
The scale of an aerial photograph can be determined a number of ways:

1. By comparison with features on an accurate topographic map (e.g. road intersections)

Scale = 1:distance on topo map/distance on photo

2. measurement between two recognisable objects on the ground using measuring tape or odometer
3. from height, altitude and focal length of the lens

Scale from altitude and focal length



Scale from altitude and focal length

Ensure all units are the same:

$$\begin{array}{ll} H = 25,000\text{ft ASL} & = 7620\text{m} \\ h = 320\text{m} & = 320\text{m} \\ f = 152\text{mm} & = 0.152\text{m} \end{array}$$

$$\text{Scale } 1: H-h/f \qquad 1:7300/0.152$$

i.e. 1:48,000

$$1\text{cm} = 48,000\text{cm} = 480\text{m}$$

Note that the scale is an average for the photo.

Factors affecting scale determination

In reality the scale will vary from one part of the photo to another for two reasons:

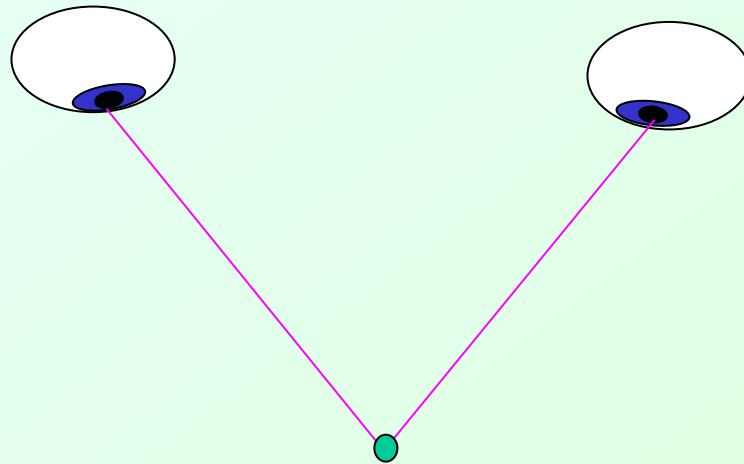
- (1) Distortion produced by the geometry of the camera → the scale around the edges of the photo is likely to be a little different from that in the centre of the photo.
- (2) Height of land surface → higher parts of the area will have higher than average scales on the photo; lower parts of the photo will have lower scales.

Stereoscopy

Stereoscopy is the science of using overlapping photographs to obtain 3-D images

We obtain 3D vision of an object naturally using two eyes

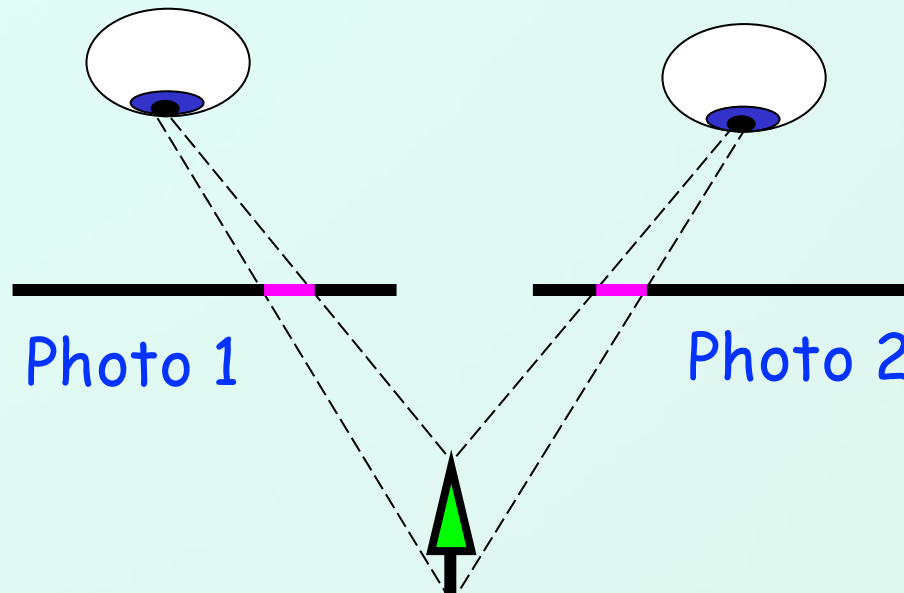
\therefore we see it from two different view points 5.5 to 7.5cm apart.



Lines of sight converge when focussing on an object

Stereoscopic viewing of aerial photographs

- If we have photographs of an object from two different perspectives and view each simultaneously, we form a stereographic image of the object.
- in stereo photo vision, left eye looks at left photograph, right eye looks at right photograph (unlike normal, where lines of sight converge).
This is not a natural way of viewing objects.
- use of stereo photo pairs artificially increases the eyebase



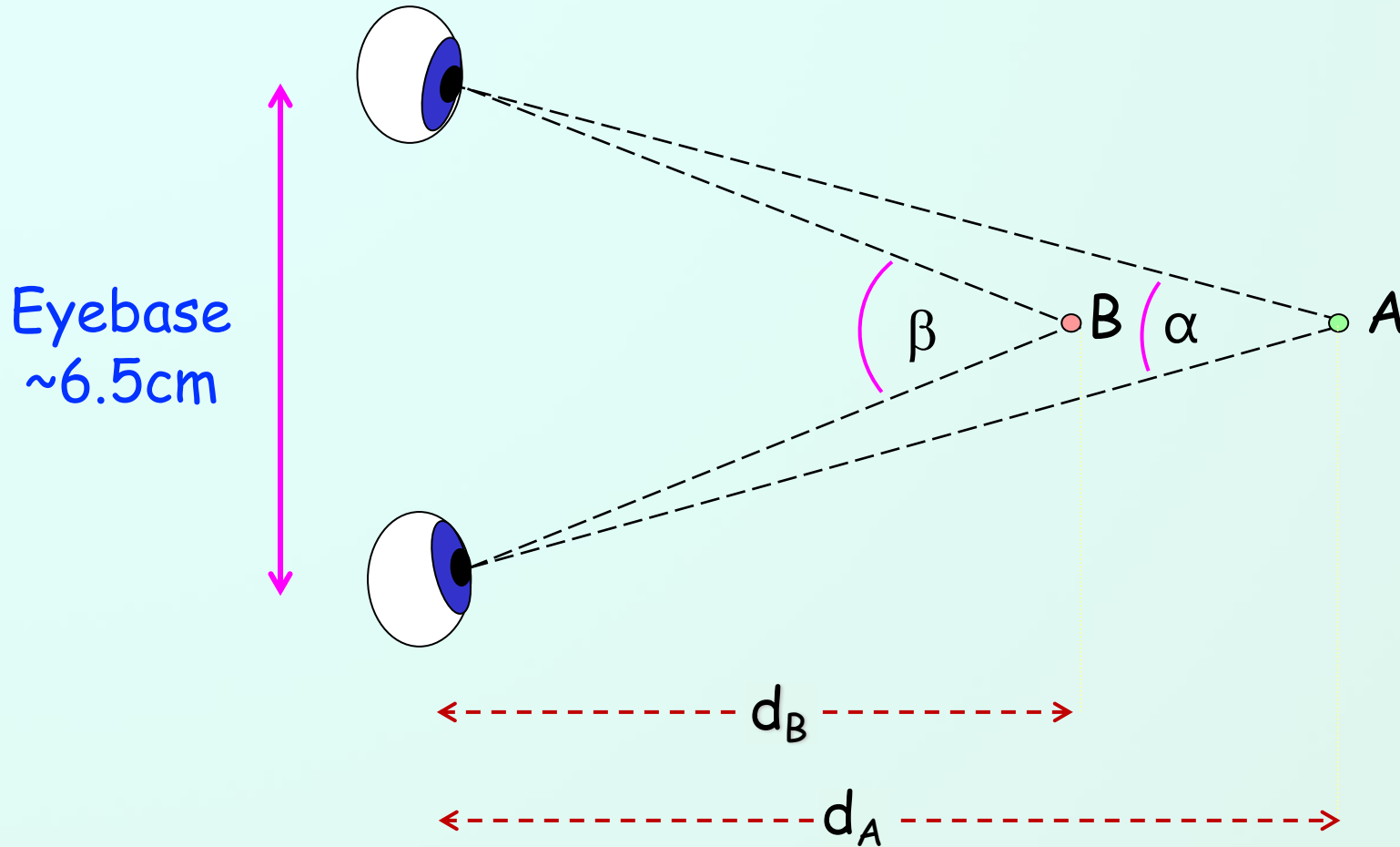
Sausage exercise

- When you focus on your fingers → lines of sight of each eye converge
- when you focus on the distant background → eyes shift slightly outwards making lines of sight nearly parallel
- for closer objects, images of fingers are no longer converged and appear double
- the farther apart your fingers are, the larger the sausage when it forms, the more nearly parallel are your lines of sight

Viewing of overlapping photographs

- With photographs of an object from two different perspectives if we view each simultaneously → left eye looks at left photo, right eye looks at right photo
- this enables viewer to obtain 3-D image
- features such as relief and structure are easier to interpret than from single photo

Geometry of 3D vision



$\beta - \alpha$ is proportional to $d_A - d_B$

Limit of stereo-perception

When viewing objects at distances greater than 500m, the ability to perceive 3D is essentially lost.

Stereoscopic vision in aerial photographs

To remedy this, the eyebase is artificially increased so that α and β increase and therefore $\beta - \alpha$ is increased

For a 60% overlap in aerial photographs 23cm x 23cm and for a scale of 1:25,000 using a 153mm lens the height above the terrain \sim 3800m. The airbase (distance between consecutive principal points) is 2300m. This acts as if the eyebase is 2300m

$\beta - \alpha$ is then large enough to give stereo-perception.

Vertical exaggeration

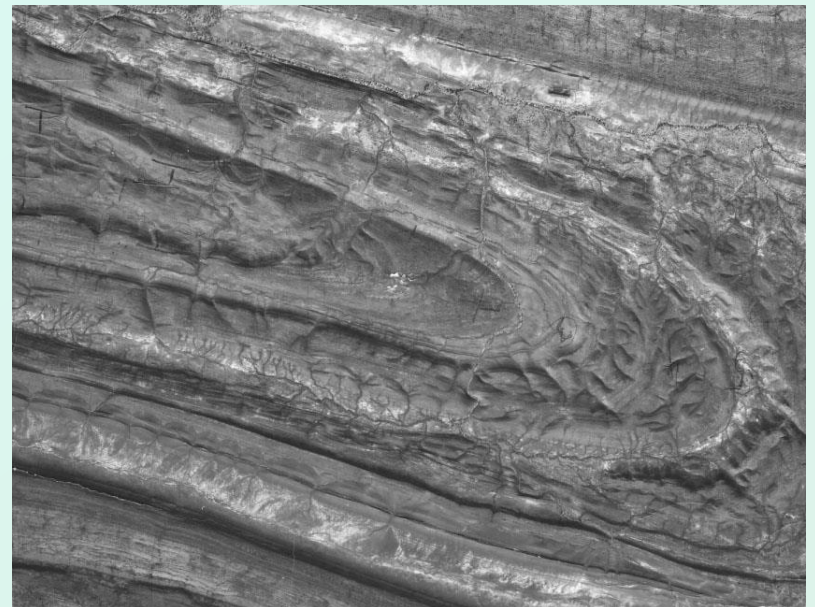
- Artificial increase in eyebase → vertical exaggeration
- exaggerated difference in relief - may be of benefit (accentuates boundaries between rocks of contrasting resistance to weathering)
- makes estimation of bedding orientation difficult

Problems associated with stereo viewing

1. People with eyes of unequal strength may have difficulty seeing in stereo.
2. Poor photographic illumination, misaligned prints or uncomfortable viewing positions may result in eye fatigue.
3. Inverted stereovision can be caused by:
 - (a) Erroneous reversal of print orientations
 - (b) Viewing photos with shadows falling away rather than towards the interpreter.

Inverted pseudoscopic relief

- When aerial photographs are viewed in certain orientations relief of photo may appear inverted → ridges appearing to be valleys and vice versa
- this phenomenon occurs because the brain assumes light source from front with shadows to the bottom



Use of aerial photos in geology

- Provide an overview of good vs poor outcrop in an area
- enable planning of traverse mapping
- may show problem areas (complex structure)
- reveal large structures that may not be recognised on the ground (e.g. folds, faults)
- enable recognition of subtle changes in rock types
- fill in gaps not mapped
- provide information for mineral exploration programs
- use as a base map for geological mapping and field navigation

Photo interpretation

- Identification of features on aerial photographs e.g. soil patterns, landscape, vegetation, visible rock outcrops may be qualitative or quantitative

Qualitative → use of photographic tones, textures and patterns to interpret expression of geological features

Quantitative → size and shape, dip and thickness and the relationship between geological planes and topography

- photo interpretation may involve a single photograph or stereo pairs
- stereographic relief enables interpretation of geological structures that may not be obvious in single photographs

Information from aerial photographs

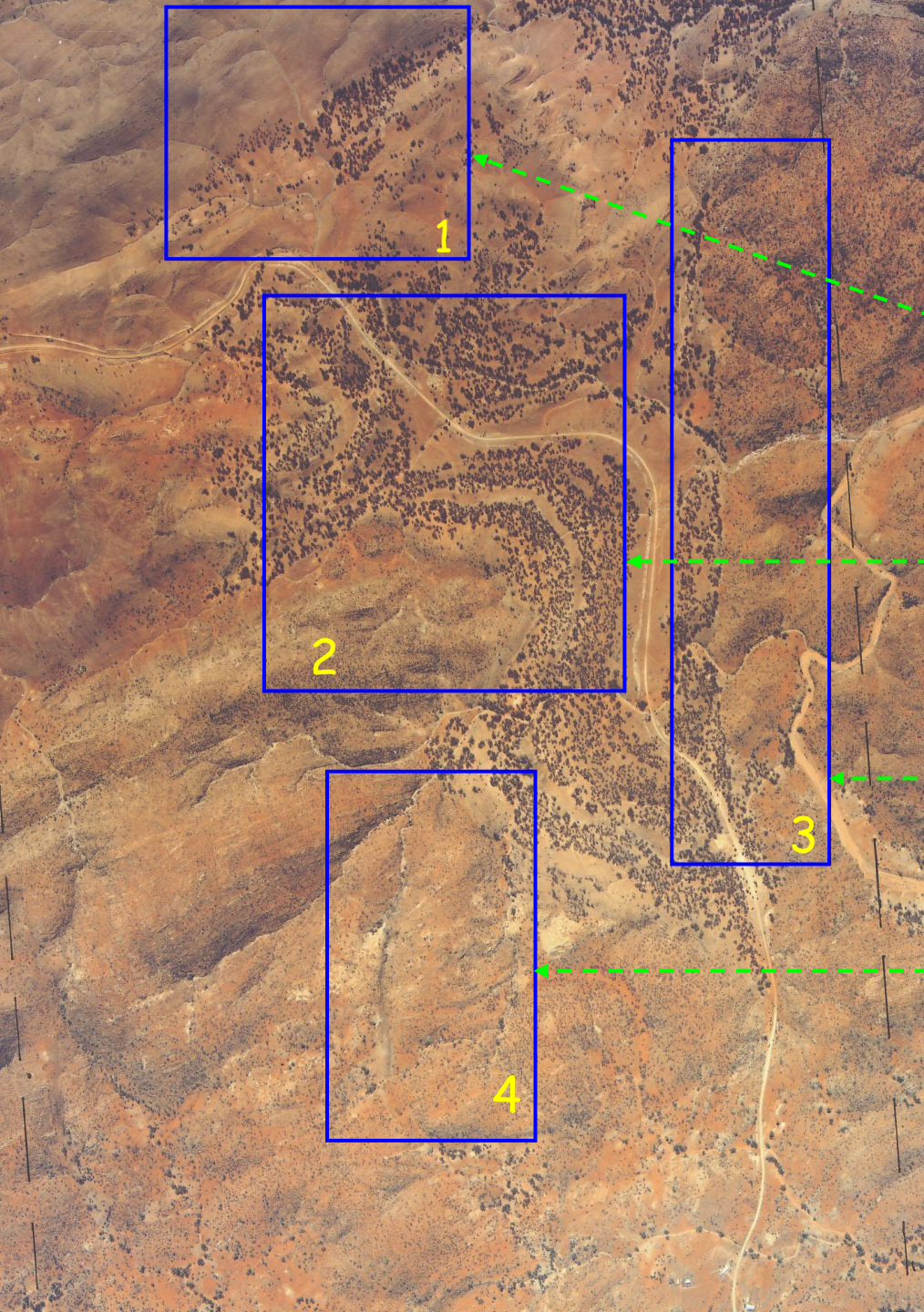
Information from single photograph

- Variations in tone, texture, pattern, shape, size and pseudoscopic relief → enables discernment of different rock units and simple geological structures

Information from stereo paired photograph

- Enables interpretation of topography
- aids in interpretation of geological structures (estimates of dip and plunge angles)

Aerial photograph Weekeroo, South Aust.



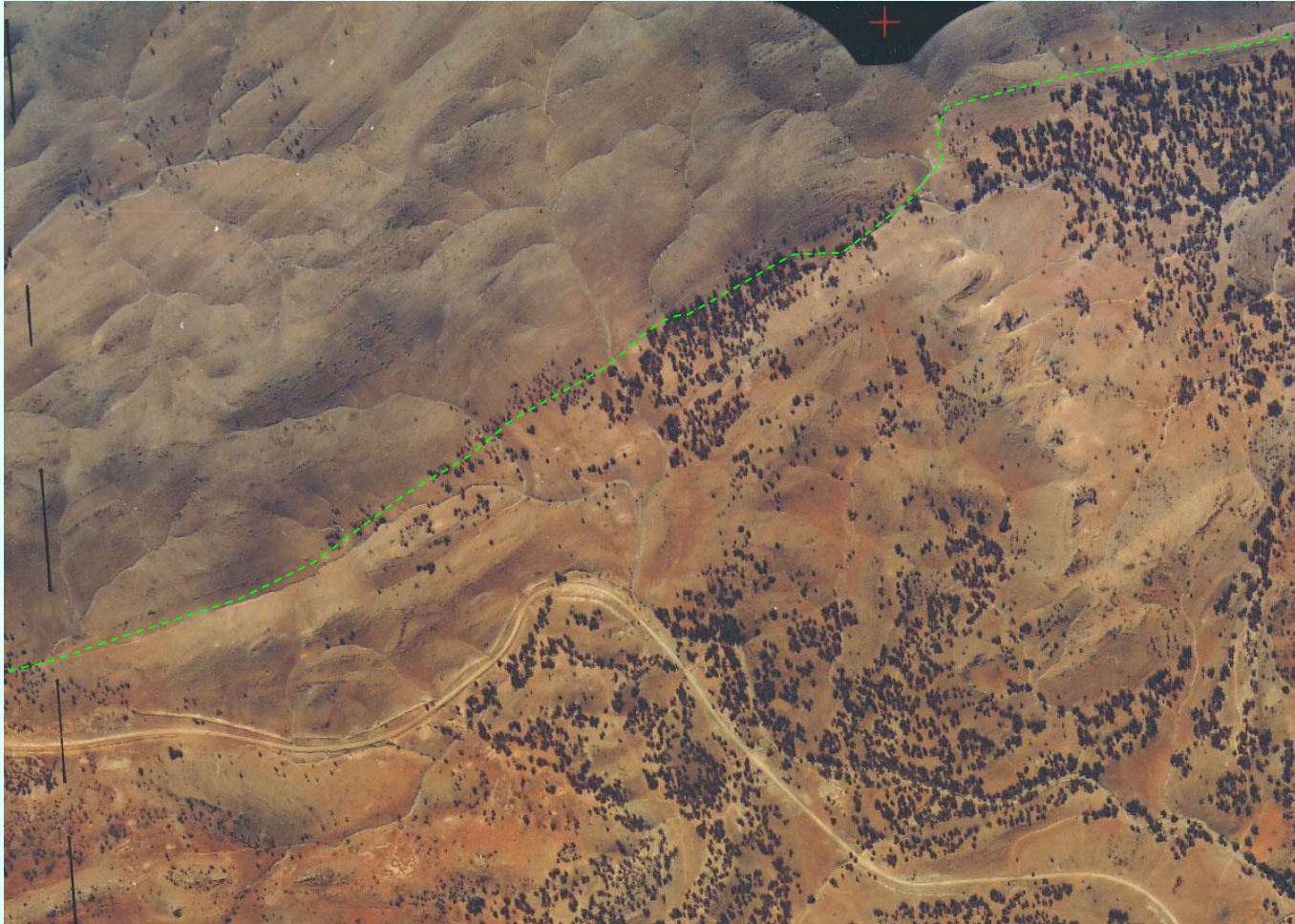
1. Lithological boundary
(change in tone)

2. Lithological boundaries
(change in vegetation)

3. Fault
(lineament)

4. Dyke

Lithological boundary (change in tone)



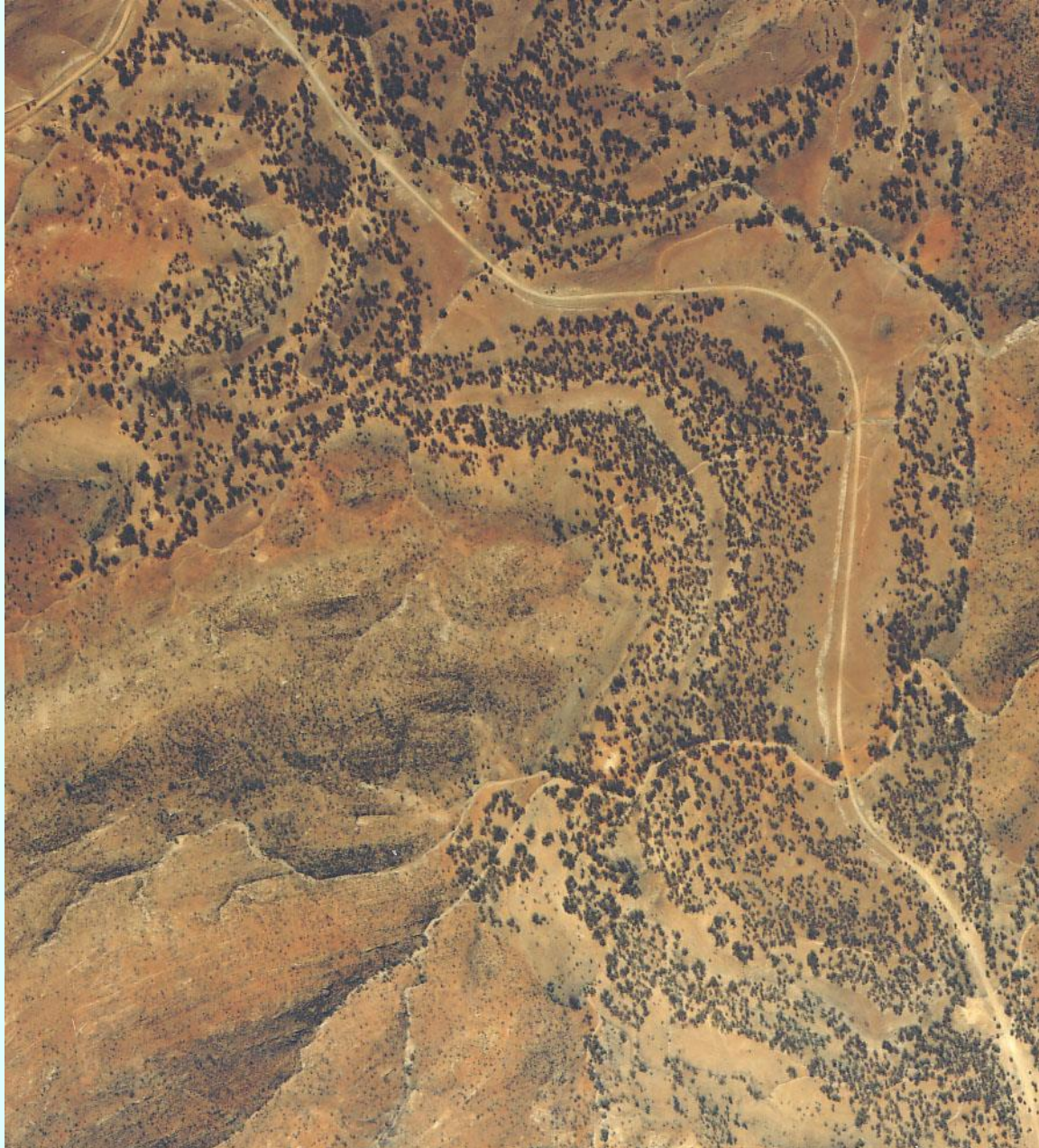
Lithological boundary (change in vegetation)



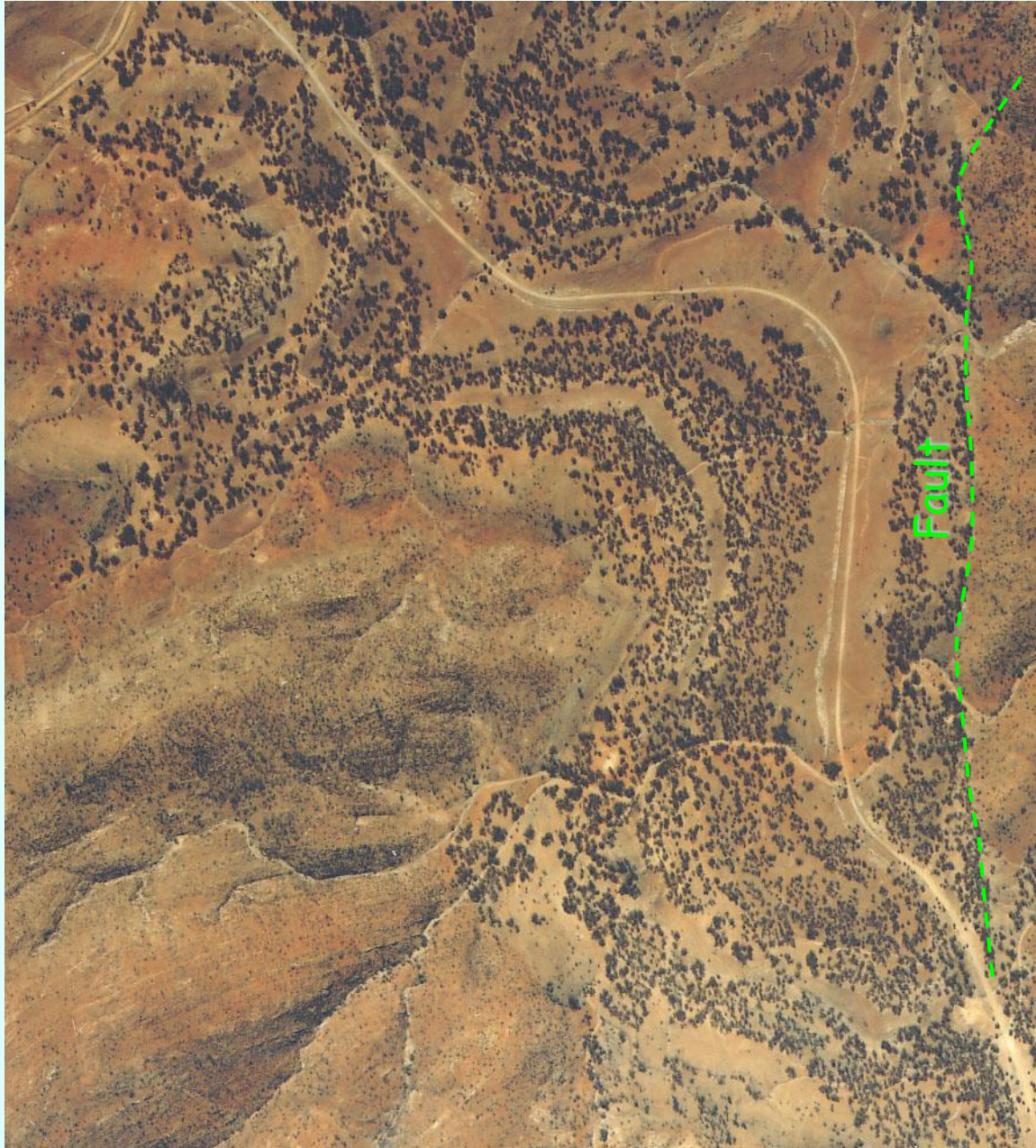
Lithological boundary (change in vegetation)



Fault



Fault



Dykes as linear features

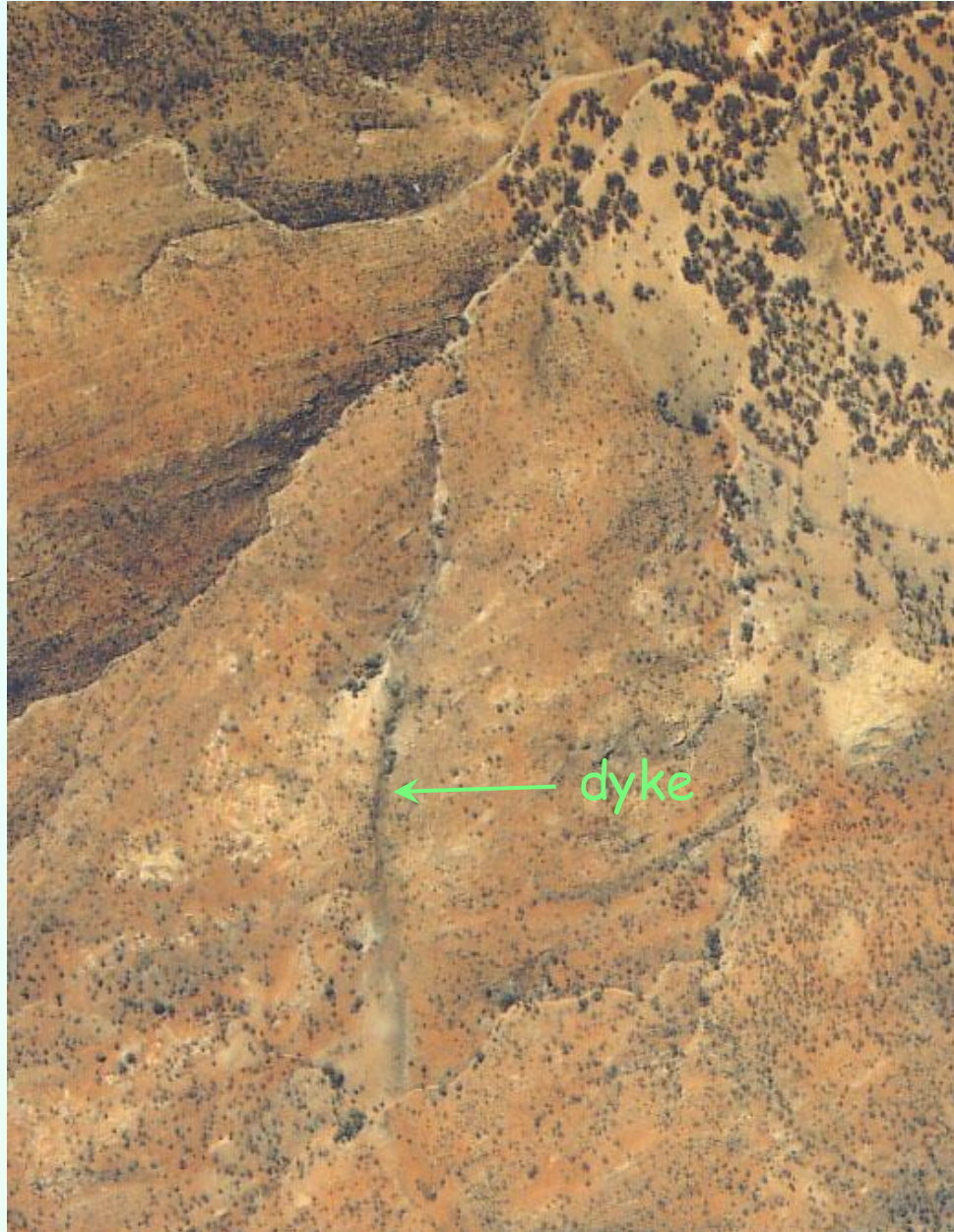


Photo recognition elements

1. Photographic tones
2. Textures
3. Patterns
4. Size
5. Shape
6. Relief

Photograph tones

- Variation in shade from black through greys to white, registered by the terrain on a panchromatic (non-coloured) photograph
- colours on coloured prints (variations in hue)

Factors affecting photographic tones

- degree and type of weathering
- soil cover and type of soil
- outcrop rock types
- position on photograph (intensity of radiation varies across photo)
- location in topography

Hints for interpreting rock type on basis of tone

(i) darker rocks tend to give darker tones

(ii) lighter rocks tend to give lighter tones



limestones

marble

sandstones

quartz schists

muscovite schists

quartzite

granite/rhyolite

mudstones

shales

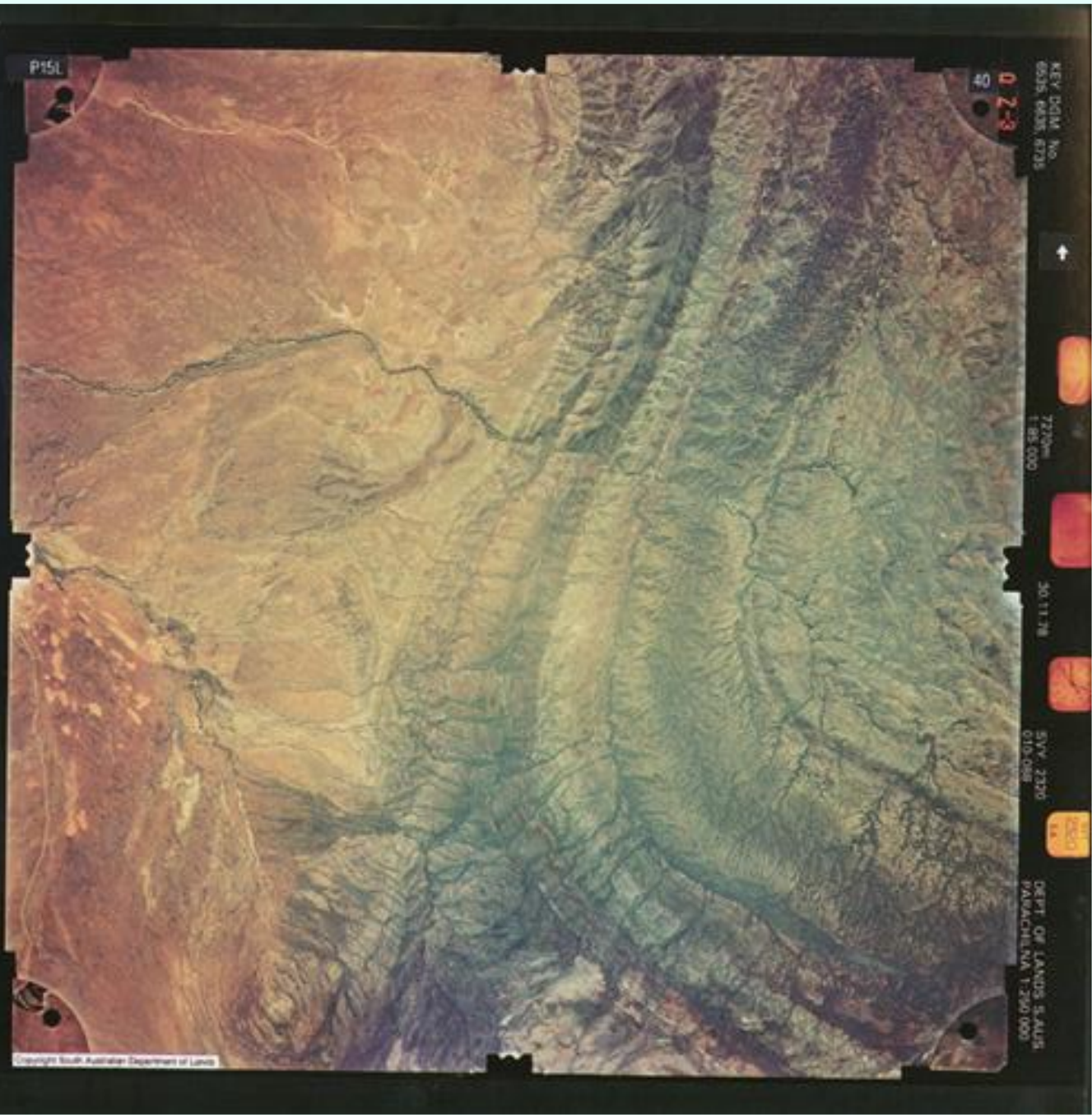
slates

biotite schist

gabbro

basalt

Parachilna
Flinders Ranges
South Aust.



Photographic tones (panchromatic photo)



Texture

- Texture refers to the degree of roughness or smoothness in the appearance of the ground surface, features generally too small to have individual significance at photo scale e.g.

mottled - patchy variation in tones

banded - well-bedded sedimentary unit

stippled- flat sandstone plateau with scattered bushes

Texture



Limitations of tone and texture

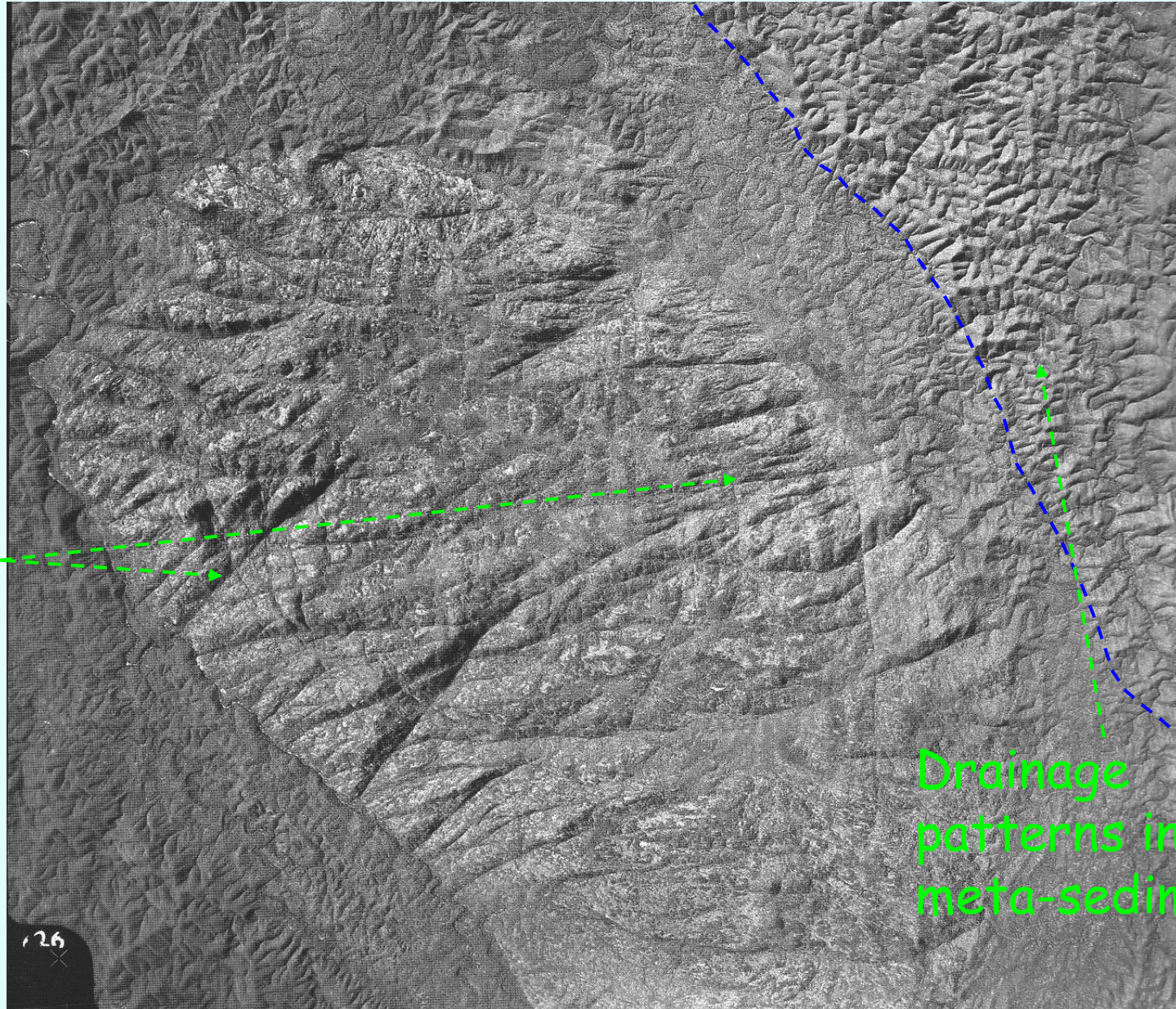
- Contrasts different rock units but can't precisely identify rock type
- best results occur where adjacent rock types have different erosional characteristics
- thick vegetation or sand cover may obscure bedrock geology

Pattern

Regularity and/or characteristic distribution of tones and/or textures e.g.

- network of fracture traces
- lineaments - linear arrangements of strain and ridge
- patterns of vegetation → often reflect geology
- drainage patterns may reflect rock type, structure etc.
- parallel set of tonal bands e.g. sequence of beds

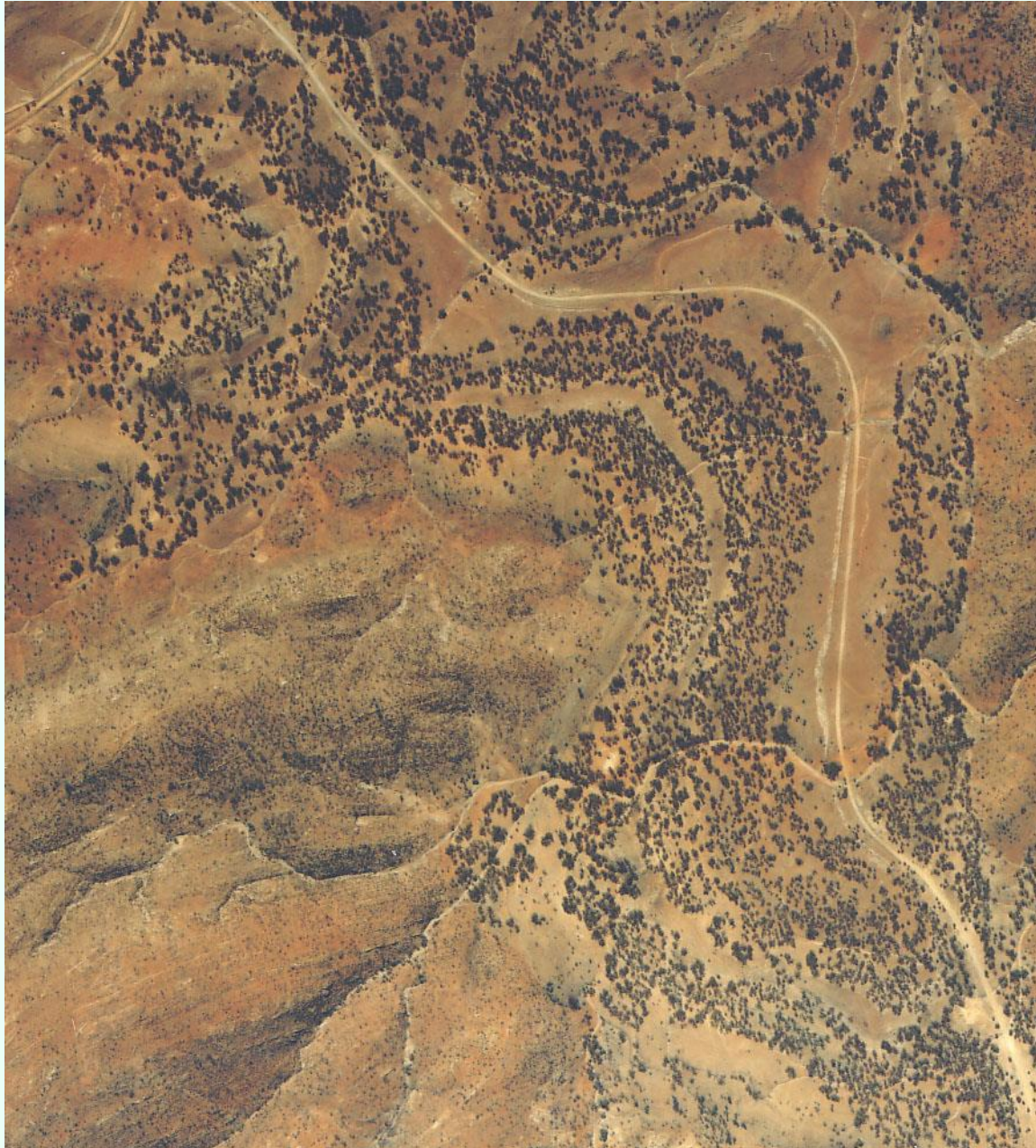
Aerial photo Mossman, Queensland



Joint traces

Drainage patterns in meta-sediments

Pattern - vegetation



Shape

- Provides diagnostic clues in identifying geological features
e.g. plutons generally elliptical in shape
- granite commonly positive relief but, if hornfels ridge
→ commonly negative relief in comparison
dolerite dyke → positive relief vs schist
→ negative relief vs quartzite
- landforms distinguished by shape e.g. volcanic cones,
sand dunes, alluvial fans, landslides, plutons etc.
- cultural features e.g. man-made features tend to have straight
edges (roads, buildings)

Volcanic cones, Harrat Khaybar Saudi Arabia



Structural features

Bedding - commonly expressed as parallel ridges or valleys (differential erosion) or textural differences (tone, vegetation, joint patterns etc.)

Folding - large scale folds are more easily seen on aerial photos than on the ground.

Determination of dip directions → plunge of fold

Lineaments - straight or gently curved line(s) e.g. faults, joints

Orientation of bedding

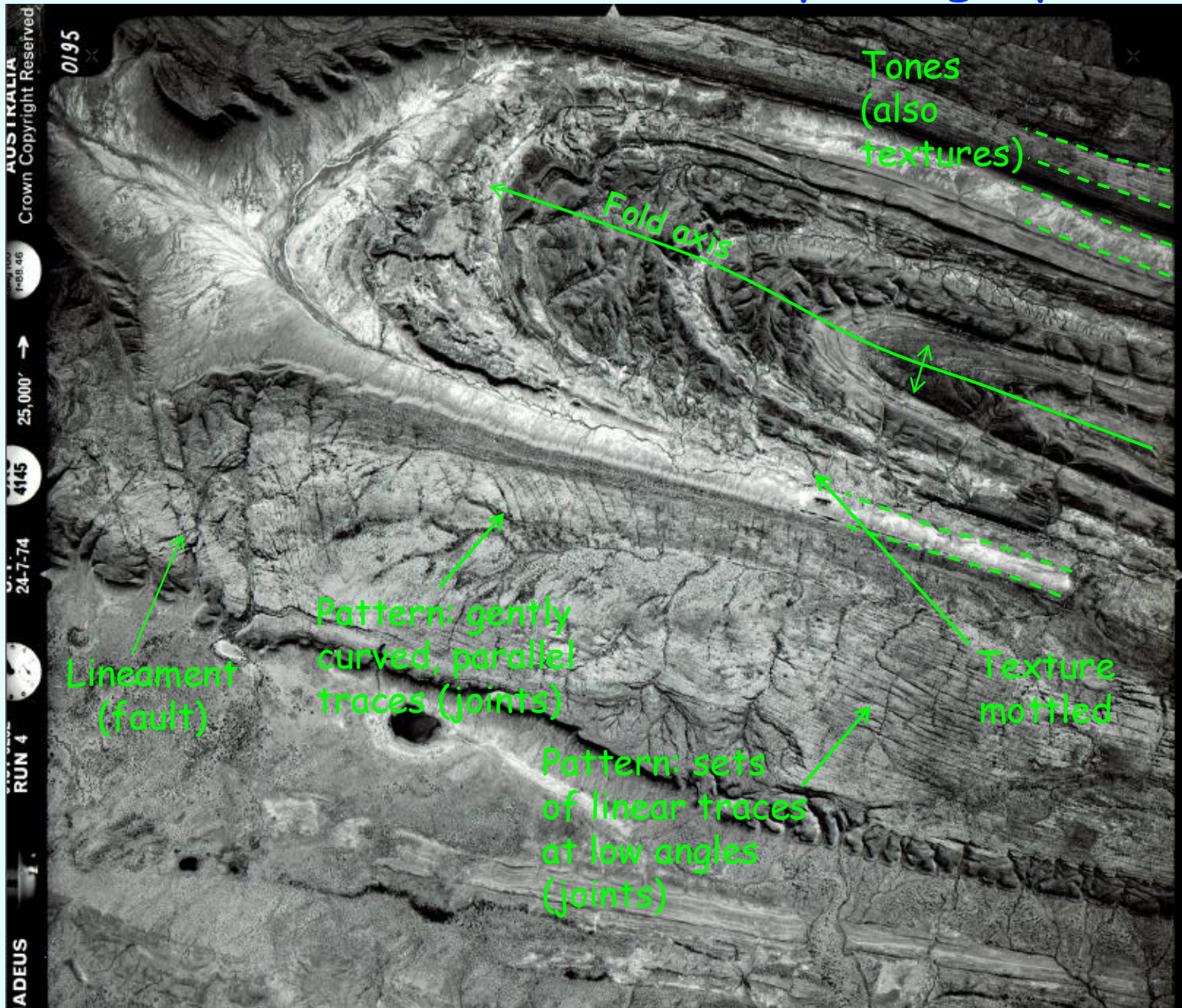
(1) Steep or vertical bedding cuts across valleys and ridges.

Horizontal beds parallel topographic contours.

(2) dip direction can be determined from rule of Vs

(3) dip degree can be estimated using paired photos

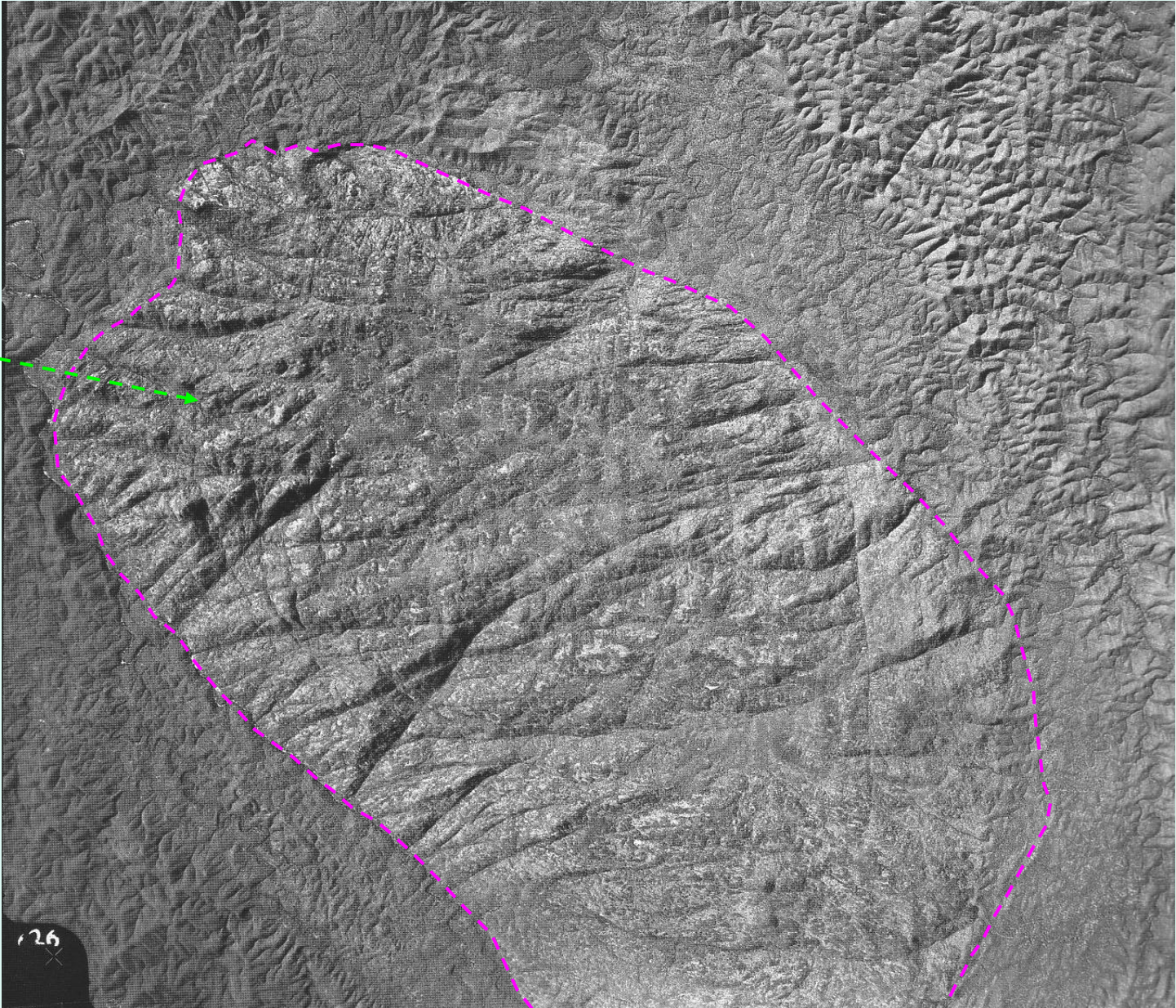
Lake Amadeus, NT aerial photograph



Lithological interpretation

- Acid (e.g. granite) lighter toned rectangular jointing vs basic (e.g. gabbro) darker toned, poor vegetation
- types - plutons tend to be elliptical or circular, but many dykes often follow joints or faults; they show tone (colour) differences, relief differences (+ve or -ve); sometimes occur in swarms, or at least a few
- basic extrusives occur as dark toned sheets
- acid extrusives may be extensive, light toned, lobate, bulbous, less flat (because of the higher viscosity of acid magmas).

Aerial photo Mossman, Queensland



pluton

Mt Bruce, WA, aerial photograph

