Institute of Natural Resources
Departament of General Geology and Land use planning

Levelling

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Plan

1. Definition;

2. The principe of levelling;

3. Error sources;

4. Parts of the instrument;

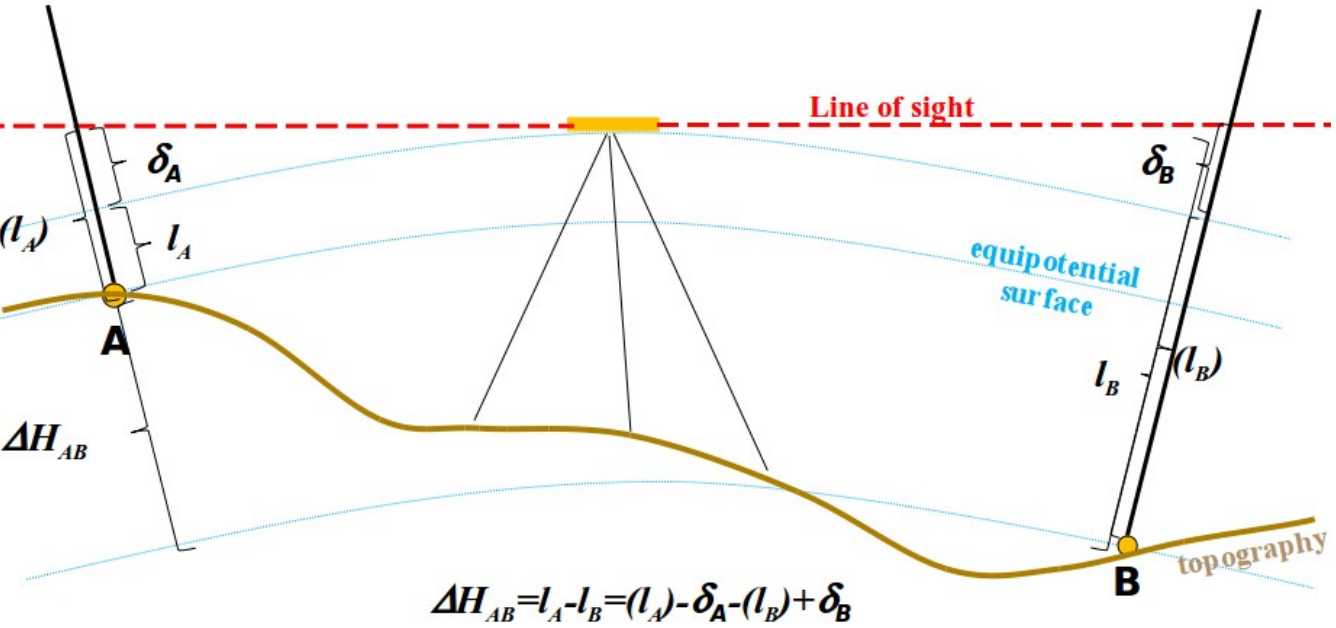
6. Setting up the level.

Definition of levelling

Levelling is the measurement of geodetic height using a levelling instrument and a level staff.

Levelling is the measurement of geodetic height using an optical levelling instrument and a level staff or rod having a numbered scale. Common levelling instruments include the spirit level, the dumpy level, the digital level, and the laser level.

The principe of levelling



$$\Delta H_{AB}=l_A-l_B=(l_A)-\delta_A-(l_B)+\delta_B$$

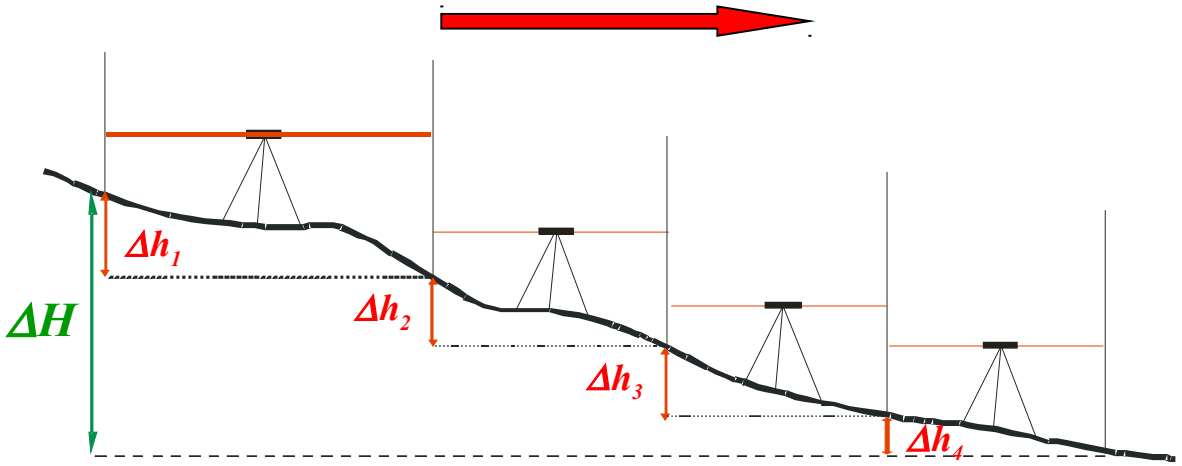
When $\delta_A=\delta_B$ (spherical approximation, equal distance to A and B)

$$\Delta H_{AB}=(l_A)-(l_B)$$

A typical procedure is to set up the instrument within 100 meters of a point of known or assumed elevation. A rod or staff is held vertical on that point and the instrument is used manually or automatically to read the rod scale. It gives the height of the instrument above the starting (backsight) point and allows the height of the instrument above the datum to be computed.

The principe of levelling

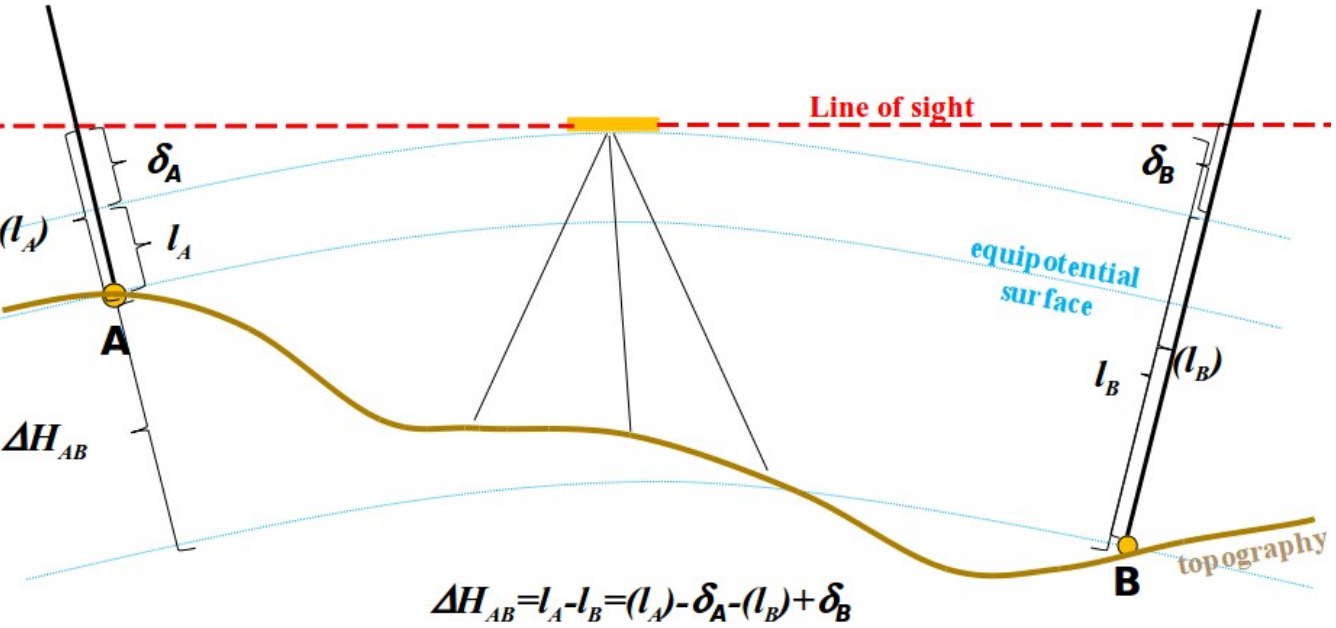
The previous procedure is repeated as many times as need to cover the distance between the points.



$$\Delta H \quad \Delta h_1 \quad \Delta h_2 \quad \Delta h_3 \quad \Delta h_4$$

$$\Delta H \quad \Sigma l_{BS} - \Sigma l_{FS}$$

Error sources 1



$$\Delta H_{AB}=l_A-l_B=(l_A)-\delta_A-(l_B)+\delta_B$$

When $\delta_A=\delta_B$ (spherical approximation, equal distance to A and B)

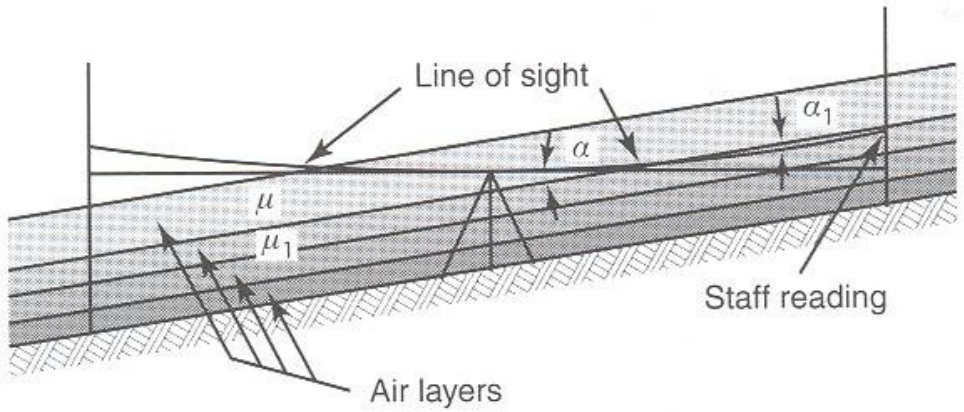
$$\Delta H_{AB}=(l_A)-(l_B)$$

Solution: Since the equipotential surface is approximately spherical, the effect of curvature is a function of the instrument-staff distance. When the backsight and foresight distances are equal, the effect of curvature cancels out.

Error sources 2

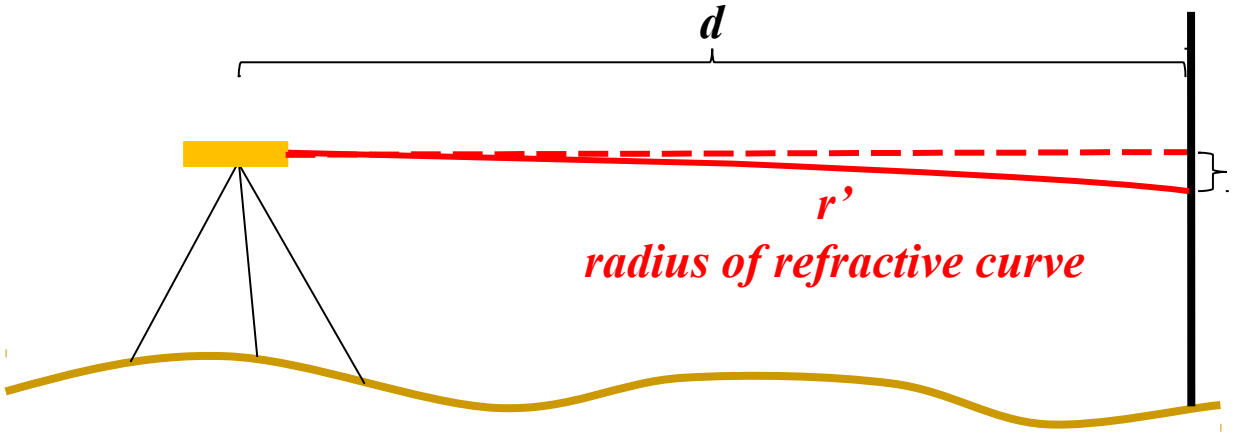
The refraction

The air has different optical properties everywhere. For example, air pressure, humidity etc. It has an impact on the refractivity. Thus the light does not propagate along a straight line, but along a curve:



For points with the same elevation, the effect of refraction can be neglected.

Error sources 3



$$\delta_r = \frac{d^2}{2r'}$$

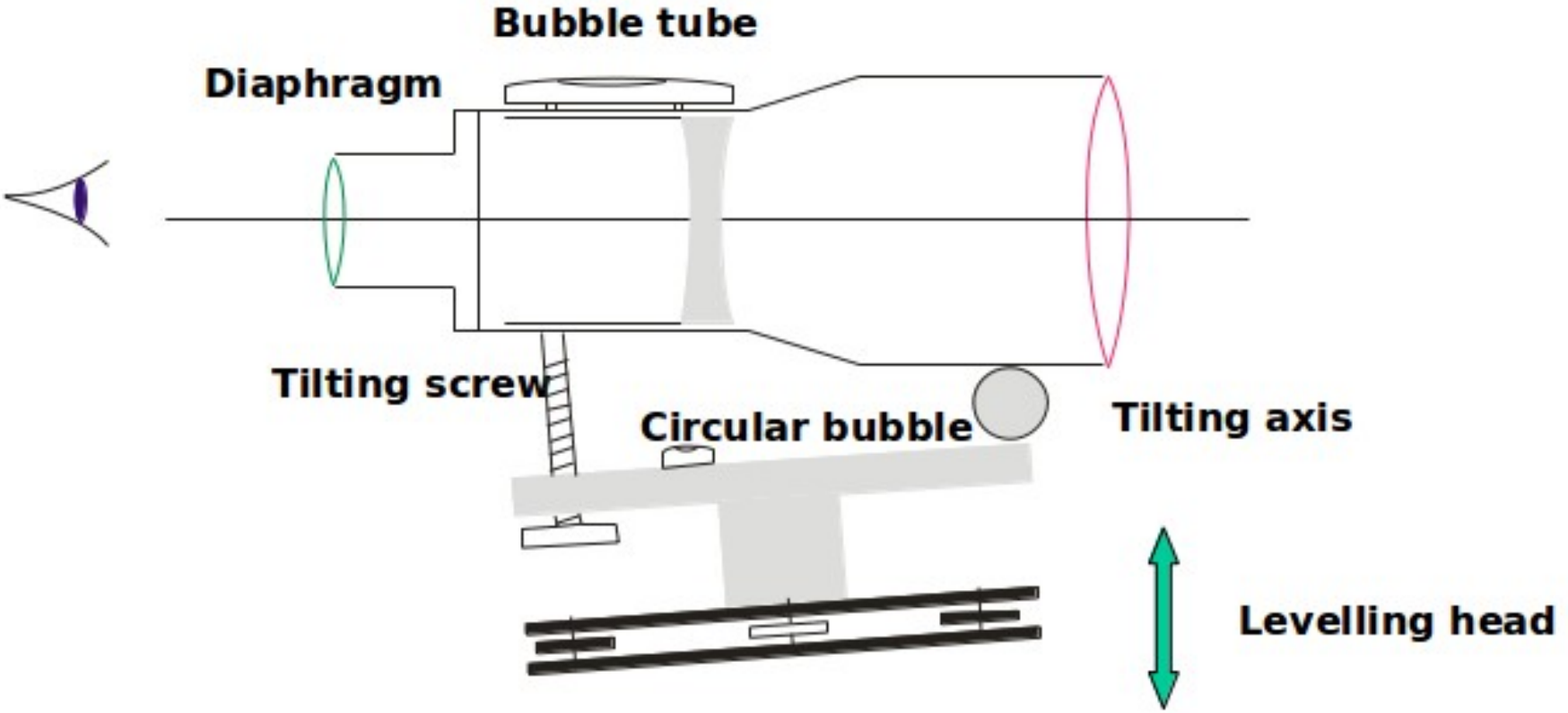
R – *Radius of the Earth*

$$\delta_r = \frac{d^2}{2r'}\frac{R}{R} = \frac{d^2}{2R}\frac{R}{r'}$$

$$introducing: k = \frac{R}{r'} \approx 0{,}13$$

Solution: the instrument should be set up exactly in the middle between two points, thus the effect of curvature is the same for the backsight and foresight.

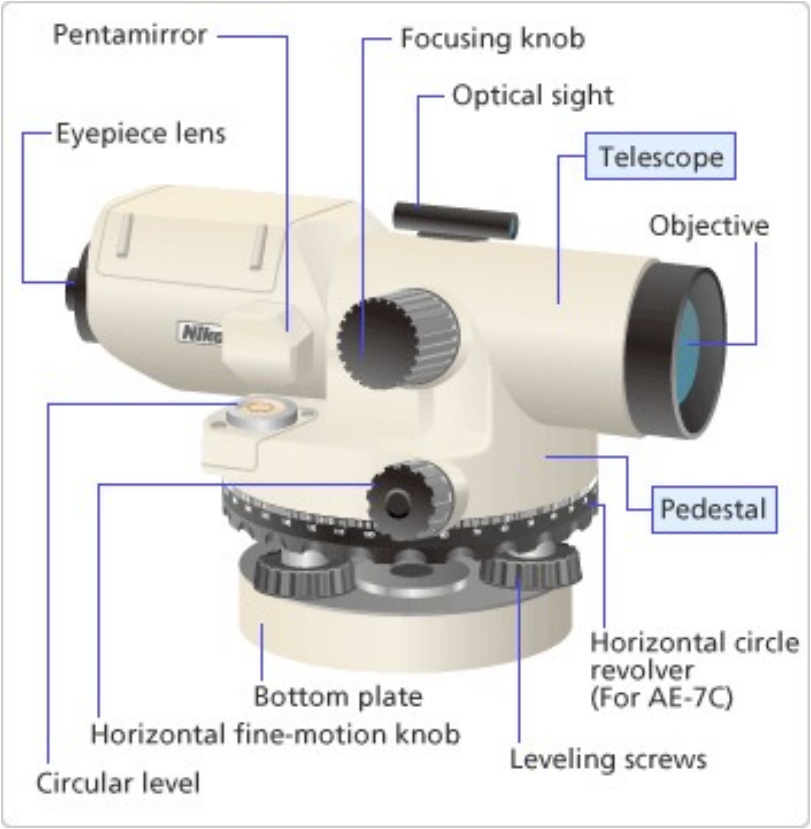
Parts of the instrument



Clamping screw — to fix the telescope in one vertical plane.

Tangent screw (slow motion screw) — to finely rotate the telescope along a vertical axis.

Parts of the instrument



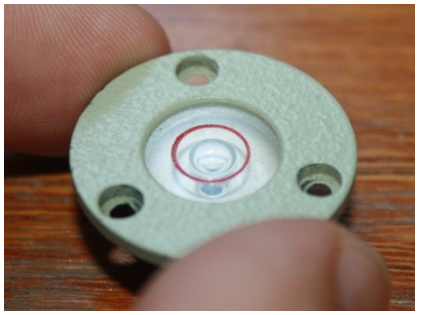
The names of the parts of the level

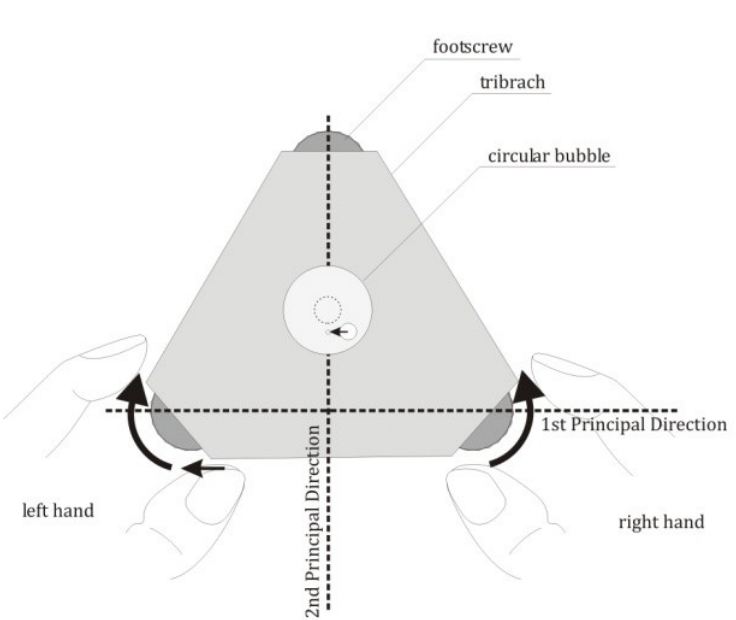
A level consists of a telescope for looking at a leveling rod, which is a kind of ruler, and a pedestal for rotating the telescope horizontally.

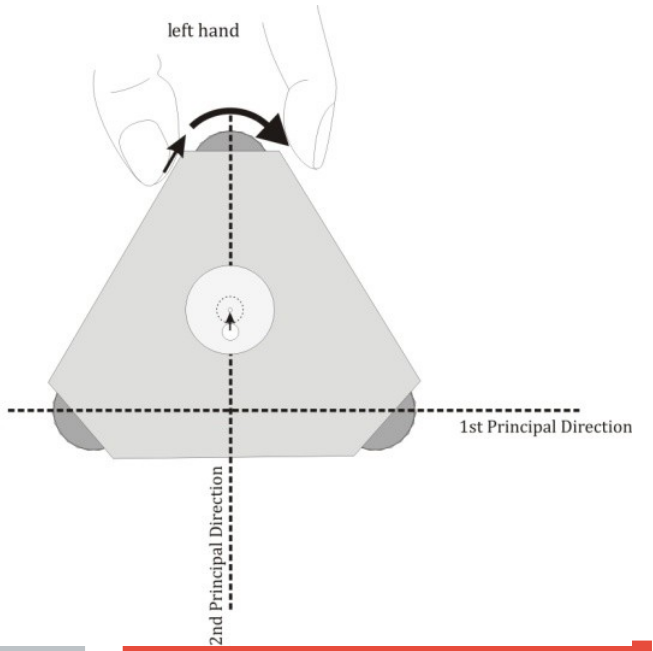
Setting up the level

1. Fix the level on a tripod;

2. Center the circular bubble by adjusting the foot screws.
(to approximately level the instrument)
3. Sight the levelling staff:
    first: rotate the telescope in the direction of the staff
    second: use the fine motion screws to ensure precise sighting
    (note: on some instruments the fine motion screw works only, when the alidade is fixed using the *fixing clamp*)
4. Adjust the levelling bubble using the levelling screw.







Thank you for attention!