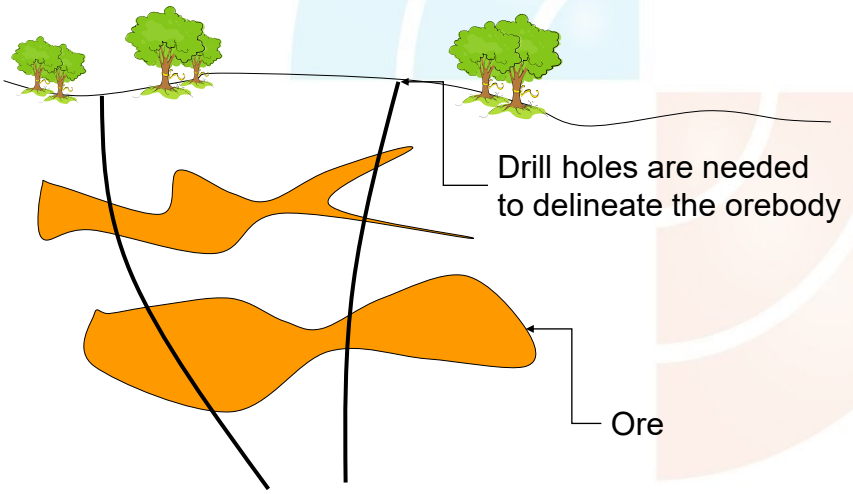

# Drillhole Data Compositing

Prof. Emmanuel Chanda (ADELAIDE)
Prof. Serkan Seydam (UNSW)
Mr. Basil Beamish (UQ)

## Outline

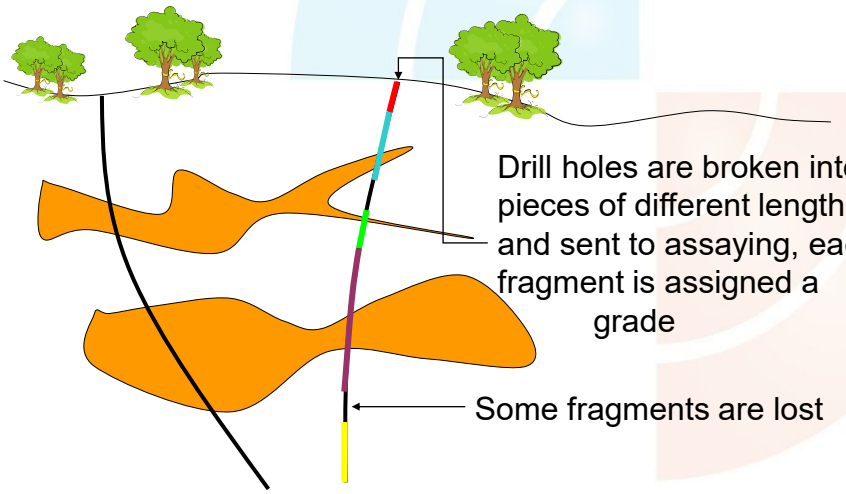
- Compositing Definition
- Bench v/s Down-hole compositing
- Compositing length selection: effect on histogram
- Numerical examples

## Drill holes (1)




## Drill holes (2)

## Drill holes (3)

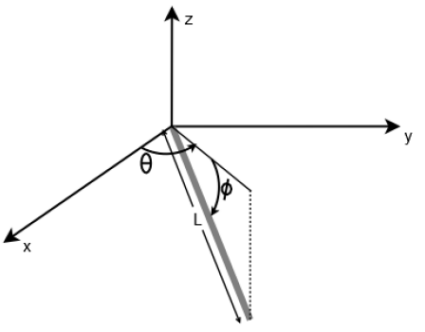


Drill holes are broken into pieces of different length and sent to assaying, each fragment is assigned a grade

Some fragments are lost

## What characterizes a drill hole?

- Collar Position: X, Y and Z coordinates for the position of the collar
- Azimuth ($\theta$): Angle measured on the horizontal plane
- Dip ($\phi$): Angle measured in the vertical plane
- Length: Distance to be drilled



# Collar File

| Drill Hole | NAD 83_E | NAD83_N | Azimuth | Dip | EOH | Start of wedge | Meterage Drilled |
|---|---|---|---|---|---|---|---|
| Q-07-01 | 383151 | 5149382 | 0 | -90 | 327.00 | - | 327.00 |
| Q-07-02 | 383061 | 5148432 | 0 | -90 | 609.00 | - | 609.00 |
| Q-07-03 | 382528 | 5148651 | 0 | -90 | 546.00 | - | 546.00 |
| Q-08-04 | 383690 | 5148934 | 0 | -90 | 410.00 | - | 410.00 |
| Q-08-05 | 383385 | 5149256 | 0 | -90 | 375.00 | - | 375.00 |
| Q-08-06 | 385050 | 5148700 | 0 | -90 | 377.00 | - | 377.00 |
| BL-07-01-W1 | 370200 | 5145537 | 0 | -90 | 345.00 | 1179.00 | 345.00 |
| BL-07-01-W2 | 370200 | 5145537 | 0 | -90 | 1524.00 | 1169.59 | 317.60 |
| BL-08-02-W1 | 369519 | 5146032 | 0 | -90 | 1487.20 | 1397.40 | 125.60 |
| BL-08-02-W2 | 369519 | 5146032 | 0 | -90 | 1520.00 | 1067.00 | 453.00 |

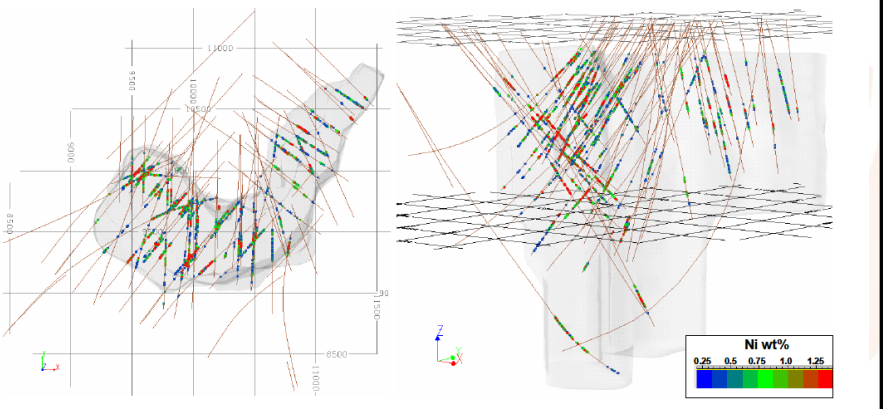
# Down Hole Survey

| DDH | Depth (M) | Dip (-) | Azimuth | Type | EOH | Remarks |
|---|---|---|---|---|---|---|
| Q-07-01 | 0.0 | 90 | 0 | Collar | 327.0 | |
| Q-07-01 | 160.0 | 80.1 | 5.3 | EZ-shot | | |
| Q-07-01 | 323.0 | 74.4 | 17.4 | EZ-shot | | |
| Q-07-02 | 0.0 | 90 | 0 | Collar | 609.0 | |
| Q-07-02 | 200.0 | 87.1 | 7.1 | EZ-shot | | |
| Q-07-02 | 400.0 | 81.1 | 8 | EZ-shot | | |
| Q-07-02 | 609.0 | 79.9 | 16 | EZ-shot | | |
| Q-07-03 | 0.0 | 90 | 0 | Collar | 546.0 | |
| Q-07-03 | 250.0 | 84.5 | 3.8 | EZ-shot | | |
| Q-07-03 | 543.0 | 83.9 | 49.7 | EZ-shot | | |
| Q-08-04 | 0.0 | 90 | 0 | Collar | 410.0 | |
| Q-08-04 | 100.0 | 89.5 | 239.4 | EZ-shot | | |
| Q-08-04 | 200.0 | 89.1 | 3.2 | EZ-shot | | |
| Q-08-04 | 300.0 | 88.4 | 3.3 | EZ-shot | | |
| Q-08-04 | 410.0 | 87.4 | 0.7 | EZ-shot | | |
| Q-08-05 | 0.0 | 90 | 0 | Collar | 375.0 | |
| Q-08-05 | 150.0 | 89.7 | 193 | EZ-shot | | |
| Q-08-05 | 175.0 | 89.6 | 220.8 | EZ-shot | | |
| Q-08-05 | 275.0 | 88.8 | 346 | EZ-shot | | |
| Q-08-05 | 375.0 | 89.4 | 337.8 | EZ-shot | | |
| Q-08-06 | 0.0 | 90 | 0 | Collar | 377.0 | |
| Q-08-06 | 100.0 | 85.8 | 345 | EZ-shot | | |
| Q-08-06 | 200.0 | 85.8 | 345 | EZ-shot | | |
| Q-08-06 | 300.0 | 84.5 | 350.7 | EZ-shot | | |
| Q-08-06 | 377.0 | 84.2 | 87.5 | EZ-shot | | |
| BL-07-01-W1 | 0.0 | 90 | 0 | Collar | 1524.0 | Old hole (KM 150-5) |
| BL-07-01-W1 | 200 | 89.3 | 227.1 | old record | | Old hole (KM 150-5) |
| BL-07-01-W1 | 400 | 88.4 | 207.6 | old record | | Old hole (KM 150-5) |
| BL-07-01-W1 | 600 | 86 | 199 | old record | | Old hole (KM 150-5) |
| BL-07-01-W1 | 800 | 81.3 | 204.2 | old record | | Old hole (KM 150-5) |
| BL-07-01-W1 | 1000 | 77.4 | 206.8 | old record | | Old hole (KM 150-5) |

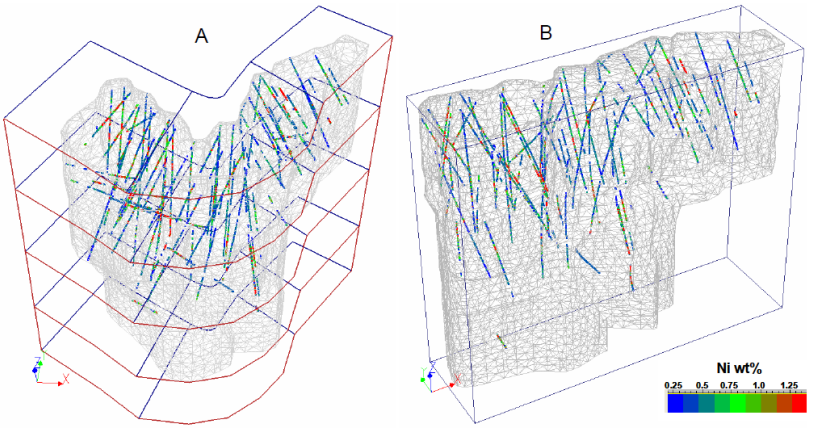
# Assay File

| HoleID | Sample No. | From (m) | To (m) | Width (m) | QAQC | File | Report Date | U ppm | $U_3O_8$ lbs/ton | Au ppb | Th ppm | ThO2 lbs/ton |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Q-07-01 | 57701 | 218.00 | 218.64 | 0.64 | | A07-6589 | 11-Feb-08 | 7.2 | 0.017 | | | |
| Q-07-01 | 57702 | 218.64 | 219.14 | 0.50 | | A07-6589 | 11-Feb-08 | 18.7 | 0.044 | | | |
| Q-07-01 | 57703 | 219.14 | 219.64 | 0.50 | | A07-6589 | 11-Feb-08 | 18.2 | 0.043 | | | |
| Q-07-01 | 57704 | 219.64 | 220.14 | 0.50 | | A07-6589 | 11-Feb-08 | 39.2 | 0.092 | | | |
| Q-07-01 | 57705 | 220.14 | 220.64 | 0.50 | | A07-6589 | 11-Feb-08 | 50 | 0.118 | | | |
| Q-07-01 | 57706 | 220.64 | 221.14 | 0.50 | | A07-6589 | 11-Feb-08 | 47 | 0.111 | | | |
| Q-07-01 | 57707 | 221.14 | 221.67 | 0.53 | | A07-6589 | 11-Feb-08 | 48.9 | 0.115 | | | |
| Q-07-01 | 57708 | 221.67 | 222.00 | 0.33 | | A07-6589 | 11-Feb-08 | 39.5 | 0.093 | | | |
| Q-07-01 | 57709 | 222.00 | 222.30 | 0.30 | | A07-6589 | 11-Feb-08 | 17.6 | 0.042 | | | |
| Q-07-01 | 57710 | 222.30 | 222.70 | 0.40 | | A07-6589 | 11-Feb-08 | 19.2 | 0.045 | | | |
| Q-07-01 | 57711 | 222.70 | 223.15 | 0.45 | | A07-6589 | 11-Feb-08 | 37.6 | 0.089 | | | |
| Q-07-01 | 57712 | 223.15 | 223.30 | 0.15 | | A07-6589 | 11-Feb-08 | 88.1 | 0.208 | | | |
| Q-07-01 | 57713 | 223.30 | 223.45 | 0.15 | | A07-6589 | 11-Feb-08 | 41.1 | 0.097 | | | |
| Q-07-01 | 57714 | 223.45 | 223.65 | 0.20 | | A07-6589 | 11-Feb-08 | 33 | 0.078 | | | |
| Q-07-01 | 57715 | 223.65 | 223.90 | 0.25 | | A07-6589 | 11-Feb-08 | 34.5 | 0.081 | | | |
| Q-07-01 | 57716 | 223.90 | 224.00 | 0.10 | | A07-6589 | 11-Feb-08 | 85.7 | 0.202 | | | |
| Q-07-01 | 57717 | 224.00 | 224.20 | 0.20 | | A07-6589 | 11-Feb-08 | 43.4 | 0.102 | | | |
| Q-07-01 | 57718 | 224.20 | 224.70 | 0.50 | | A07-6589 | 11-Feb-08 | 13.4 | 0.032 | | | |
| Q-07-01 | 57719 | 224.70 | 225.32 | 0.62 | | A07-6589 | 11-Feb-08 | 11.7 | 0.028 | | | |
| Q-07-01 | 57720 | 225.32 | 225.39 | 0.07 | | A07-6589 | 11-Feb-08 | 231 | 0.545 | | | |
| Q-07-01 | 57721 | 234.70 | 235.00 | 0.30 | | A07-6589 | 11-Feb-08 | 26.2 | 0.062 | | | |
| Q-07-01 | 57722 | 235.00 | 236.00 | 1.00 | | A07-6589 | 11-Feb-08 | 11.4 | 0.027 | | | |
| Q-07-01 | 57773 | 236.00 | 236.30 | 0.30 | | A07-6589 | 11-Feb-08 | 10.2 | 0.024 | | | |
| Q-07-01 | 57774 | 236.30 | 236.40 | 0.10 | | A07-6589 | 11-Feb-08 | 93.8 | 0.221 | | | |
| Q-07-01 | 57775 | 236.40 | 237.00 | 0.60 | | A07-6589 | 11-Feb-08 | 24.3 | 0.057 | | | |
| Q-07-01 | 57776 | 237.00 | 237.60 | 0.60 | | A07-6589 | 11-Feb-08 | 6.3 | 0.015 | | | |
| Q-07-01 | 57777 | 237.60 | 238.85 | 1.25 | | A07-6589 | 11-Feb-08 | 16.4 | 0.039 | | | |
| Q-07-01 | 57723 | 238.85 | 239.40 | 0.55 | | A07-6589 | 11-Feb-08 | 71.8 | 0.169 | | | |
| Q-07-01 | 57724 | 239.40 | 239.63 | 0.23 | | A07-6589 | 11-Feb-08 | 27.3 | 0.064 | | | |
| Q-07-01 | 57725 | 239.63 | 239.90 | 0.27 | | A07-6589 | 11-Feb-08 | 464 | **1.094** | | 845 | 1.93 |
| Q-07-01 | 57726 | 239.90 | 240.10 | 0.20 | | A07-6589 | 11-Feb-08 | 60.7 | 0.143 | | 216 | 0.49 |
| Q-07-01 | 57727 | 240.10 | 240.45 | 0.35 | | A07-6589 | 11-Feb-08 | 43.9 | 0.104 | | 133 | 0.30 |
| Q-07-01 | 57728 | 240.45 | 240.65 | 0.20 | | A07-6589 | 11-Feb-08 | 14.5 | 0.034 | | 36 | 0.08 |
| Q-07-01 | 57729 | 240.65 | 240.97 | 0.32 | | A07-6589 | 11-Feb-08 | 471 | **1.111** | | 574 | 1.31 |
| Q-07-01 | 57730 | 240.97 | 241.20 | 0.23 | | A07-6589 | 11-Feb-08 | 181 | 0.427 | | 332 | 0.76 |
| Q-07-01 | 57731 | 241.20 | 241.33 | 0.13 | | A07-6589 | 11-Feb-08 | 62.2 | 0.147 | | 133 | 0.30 |
| Q-07-01 | 57732 | 241.33 | 241.51 | 0.18 | | A07-6589 | 11-Feb-08 | 291 | **0.686** | | 618 | 1.41 |
| Q-07-01 | 57733 | 241.51 | 241.77 | 0.26 | | A07-6589 | 11-Feb-08 | 216 | 0.509 | | 332 | 0.76 |
| Q-07-01 | 57734 | 241.77 | 241.90 | 0.13 | | A07-6589 | 11-Feb-08 | 19.9 | 0.047 | | 41 | 0.09 |
| Q-07-01 | 57735 | 241.90 | 242.20 | 0.30 | | A07-6589 | 11-Feb-08 | 111 | 0.262 | | 332 | 0.76 |
| Q-07-01 | 57736 | 242.20 | 242.45 | 0.25 | | A07-6589 | 11-Feb-08 | 253 | 0.597 | | 456 | 1.04 |
| Q-07-01 | 57737 | 242.45 | 242.88 | 0.43 | | A07-6589 | 11-Feb-08 | 49.9 | 0.118 | | 90 | 0.21 |
| Q-07-01 | 57738 | 242.88 | 243.08 | 0.20 | | A07-6589 | 11-Feb-08 | 379 | **0.894** | | 706 | 1.61 |
| Q-07-01 | 57739 | 243.08 | 243.23 | 0.15 | | A07-6589 | 11-Feb-08 | 82.3 | 0.194 | | 188 | 0.43 |
| Q-07-01 | 57740 | 243.23 | 243.42 | 0.19 | | A07-6589 | 11-Feb-08 | 290 | **0.684** | | 408 | 0.93 |
| Q-07-01 | 57741 | 243.42 | 243.68 | 0.26 | | A07-6589 | 11-Feb-08 | 700 | **1.651** | | 857 | 1.95 |
| Q-07-01 | 57742 | 243.68 | 243.91 | 0.23 | | A07-6589 | 11-Feb-08 | 358 | **0.844** | | 874 | 1.99 |

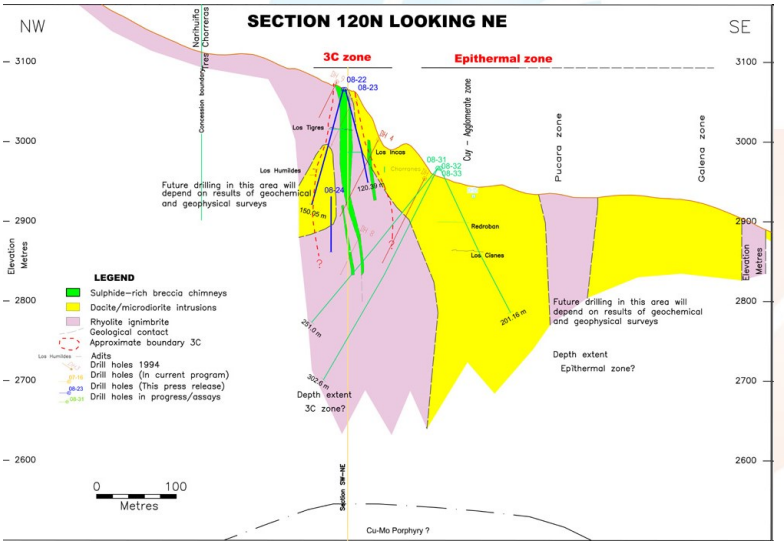
# How it looks



# Changes of coordinates in Complex Geometries




# Drill hole plan



## Some questions…

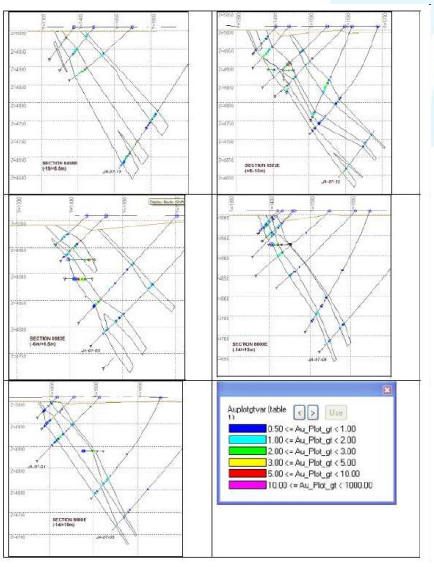
- Are these samples collected in this way usable for estimation purposes?
  - Generally speaking no. Some extra work has to be done.
- Does different segment sizes affect the true grade distribution?
  - Yes, for example consider the following hypothetical drill hole and two segments:

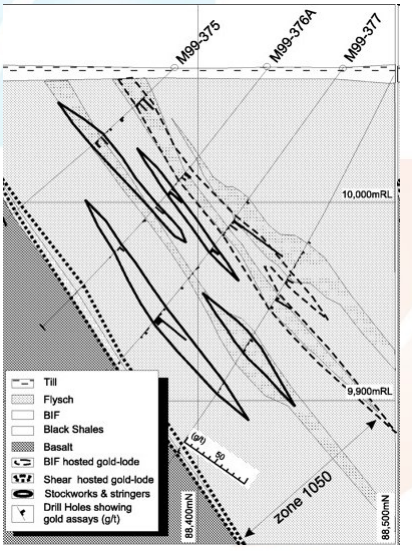
| 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 |
|---|---|---|---|---|---|---|---|

⇩ ⇩

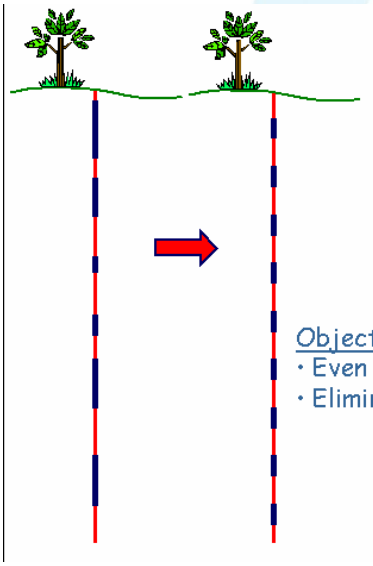
1 0 ⇨ 0.5 (average) (should be 0.75)

## Sectional interpretation





# Compositing



Compositing requires a representative composite length to be selected and sample grades be distributed along the drillholes according to this length.

Objectives:
- Even representation of sample grades
- Eliminate bias due to sample length




## Compositing

- Compositing is a technique by which assay data are combined to form weighted average or composite grades representative of intervals *longer* than their own (length-weighted average) (Hustrulid-Kutcha, 2006)

$$\text{Composite}(g) = \frac{\sum l_i \cdot g_i}{\sum l_i}$$

With $g$ being a variable of interest that we would like to composite

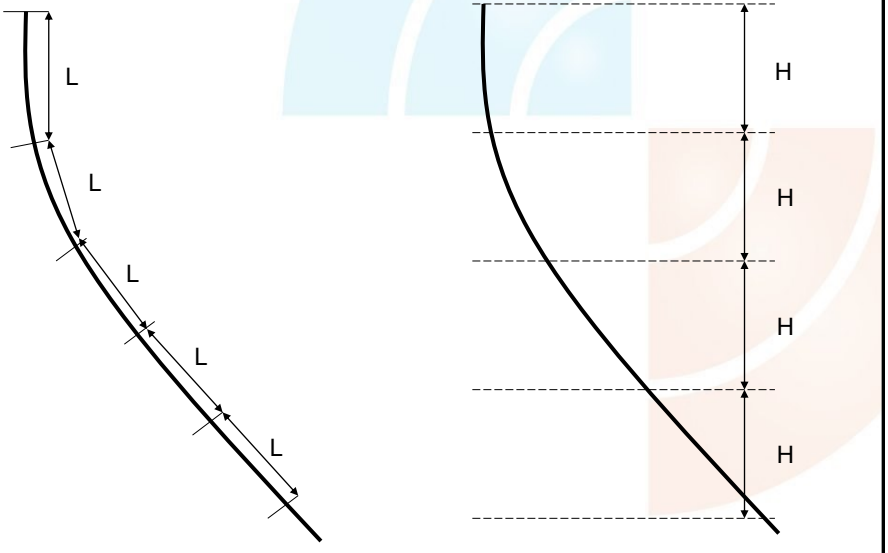
## Using Density as Weights

- Compositing formula can be changed to include density as a weighting factor

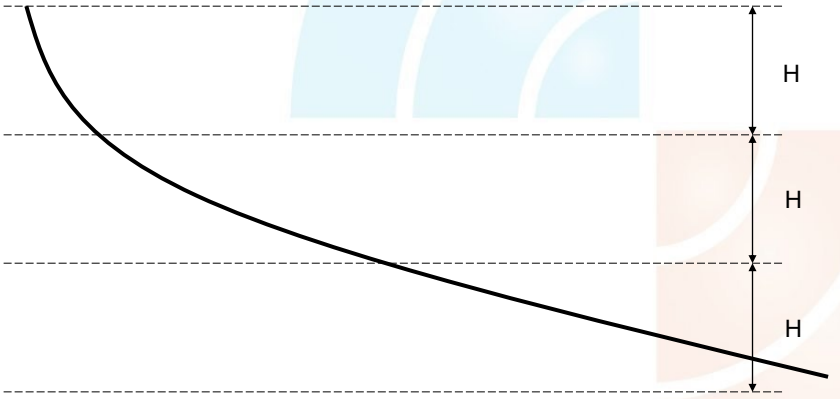
$$\text{Composite}(g) = \frac{\sum l_i \cdot g_i \cdot \delta_i}{\sum l_i \cdot \delta_i}$$

Here $\delta_i$ is the relative density of the sample portion $i$. Note that if we composite relative density then the previous formula applies (we cannot weight using relative density to composite relative density).

## Down hole compositing v/s Bench compositing

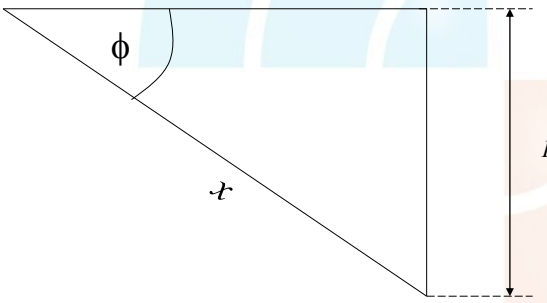


## Bench compositing issue




If drill hole is horizontal enough then the piece is going to be very large, so bench compositing is recommended just if the drill holes are reasonably vertical

## Bench compositing



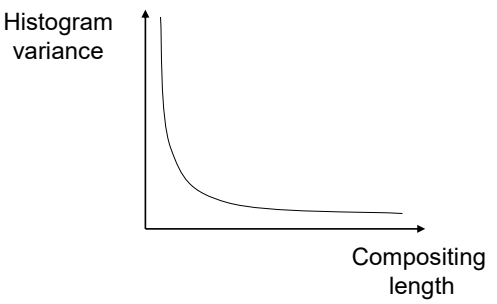

$$x = \frac{H}{\sin\phi}$$

## Compositing length selection

- There is no rule for determining the compositing length
- Usually the compositing length is equal to the bench size (for open pit projects) or the block size (underground projects)
- One useful trick is to consider the average length of the samples and use this as the compositing length
- You have to remember that any selection made has to be based on some criteria and not simply because you like it

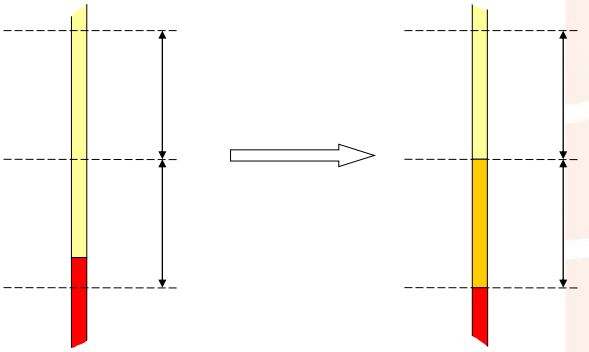
## Effect of compositing on histogram

- Larger compositing sizes will reduce the variability of the samples histogram (volume-variance effect)
- Conversely, smaller compositing sizes will increase the variability of the samples histogram



## Some remarks

- If the compositing length is less than a portion of core then the drill hole is breaken into smaller pieces.



## Example (1) – Solve in class as Tutorial (T2)

The following file contains information for drill hole JS-675:

| BHID | FROM | TO | GRADE |
|---|---|---|---|
| JS-675 | 0 | 0.45 | 1.45 |
| JS-675 | 0.45 | 0.92 | 1.42 |
| JS-675 | 0.92 | 1.28 | 1.41 |
| JS-675 | 1.28 | 1.70 | 1.42 |
| JS-675 | 1.70 | 2.10 | 1.44 |
| JS-675 | 2.10 | 2.62 | 1.42 |
| JS-675 | 2.62 | 3.03 | 1.43 |
| JS-675 | 3.03 | 3.42 | 1.41 |
| JS-675 | 3.42 | 3.82 | 1.39 |
| JS-675 | 3.82 | 4.19 | 1.41 |
| JS-675 | 4.19 | 4.64 | 1.37 |
| JS-675 | 4.64 | 4.94 | 1.40 |
| JS-675 | 4.94 | 5.28 | 1.49 |
| JS-675 | 5.28 | 5.63 | 1.60 |
| JS-675 | 5.63 | 6.03 | 1.68 |

Assuming the drill hole is vertical you are asked to **composite** the samples at
(a) 1.0-m intervals
(b) 1.5-metre intervals

# Example 1 - Solution

| | BHID | FROM | TO | GRADE |
|---|---|---|---|---|
| 0.45 | JS-675 | 0 | 0.45 | 1.45 |
| 0.47 | JS-675 | 0.45 | 0.92 | 1.42 |
| 0.36 | JS-675 | 0.92 | 1.28 | 1.41 |
| 0.42 | JS-675 | 1.28 | 1.70 | 1.42 |
| 0.40 | JS-675 | 1.70 | 2.10 | 1.44 |
| 0.52 | JS-675 | 2.10 | 2.62 | 1.42 |
| 0.41 | JS-675 | 2.62 | 3.03 | 1.43 |
| 0.39 | JS-675 | 3.03 | 3.42 | 1.41 |
| 0.40 | JS-675 | 3.42 | 3.82 | 1.39 |
| 0.37 | JS-675 | 3.82 | 4.19 | 1.41 |
| 0.45 | JS-675 | 4.19 | 4.64 | 1.37 |
| 0.30 | JS-675 | 4.64 | 4.94 | 1.40 |
| 0.34 | JS-675 | 4.94 | 5.28 | 1.49 |
| 0.35 | JS-675 | 5.28 | 5.63 | 1.60 |
| 0.40 | JS-675 | 5.63 | 6.03 | 1.68 |

| Length | Length*Grade |
|---|---|
| 0.45 | 0.6525 |
| 0.47 | 0.6674 |
| 0.08 | 0.1128 |
| | 1.4327 |

| Length | Length*Grade |
|---|---|
| 0.28 | 0.3948 |
| 0.42 | 0.5964 |
| 0.3 | 0.432 |
| | 1.42 |

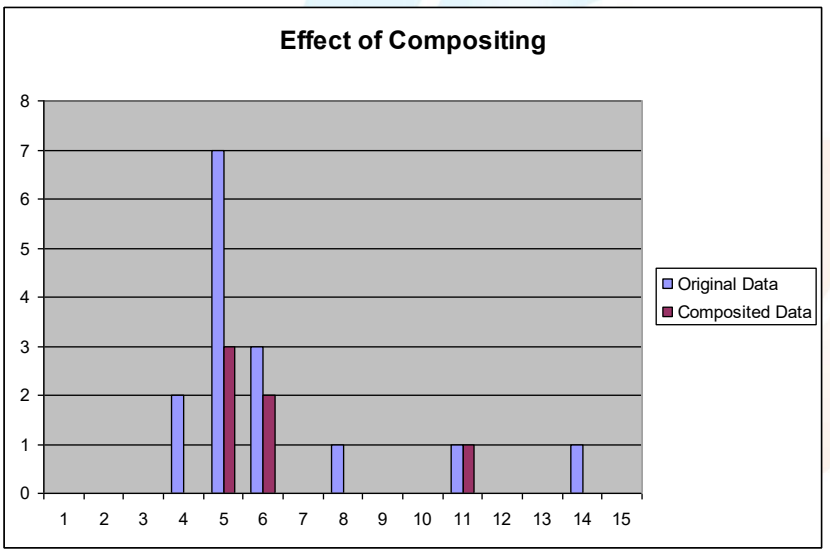
| Length | Length*Grade |
|---|---|
| 0.1 | 0.144 |
| 0.52 | 0.7384 |
| 0.38 | 0.5434 |
| | 1.4258 |

| Length | Length*Grade |
|---|---|
| 0.03 | 0.0429 |
| 0.39 | 0.5499 |
| 0.4 | 0.556 |
| 0.18 | 0.2538 |
| | 1.4026 |

| Length | Length*Grade |
|---|---|
| 0.19 | 0.2679 |
| 0.45 | 0.6165 |
| 0.3 | 0.42 |
| 0.06 | 0.0894 |
| | 1.3938 |

| Length | Length*Grade |
|---|---|
| 0.28 | 0.4172 |
| 0.35 | 0.56 |
| 0.37 | 0.6216 |
| | 1.5988 |

# Example (3)



## Benefits of Compositing

1. Irregular length assay samples must be composited to provide representative data for analysis.
2. Compositing incorporates dilution such as that from mining constant height benches in an open pit mine.
3. Compositing reduces erratic variation due to very high or very low assay values.
4. By compositing, the number of data, and hence the required computational times, are reduced.