Analyzing the *del* Gene Cluster for Gold Biomineralization across *Delftia* spp.

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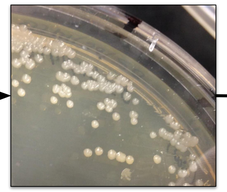
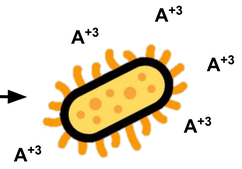
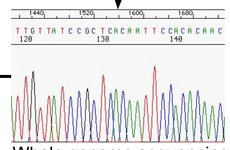
Introduction

Delftia acidovorans was identified as one of the main species of biofilms on gold nuggets[1].

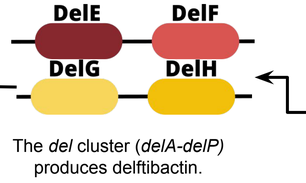




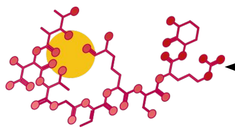
Gold ions are toxic to bacteria, yet *D. acidovorans* tolerates high concentrations of gold ions[1].



Whole genome sequencing



The *del* cluster (*delA-delP*) produces delftibactin.



Delftibactin forms solid gold nanoparticles from gold ions.

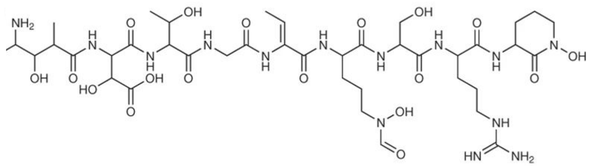


Figure 1. Structure of delftibactin, produced by *D. acidovorans* to protect against gold toxicity by producing gold nanoparticles[1].

This project investigates the presence and similarity of the *del* cluster within the *Delftia* genus and searches metagenomic data from sites around the world to gain insights into the environmental presence of *D. acidovorans* and better understand its ability to produce delftibactin.

Methods

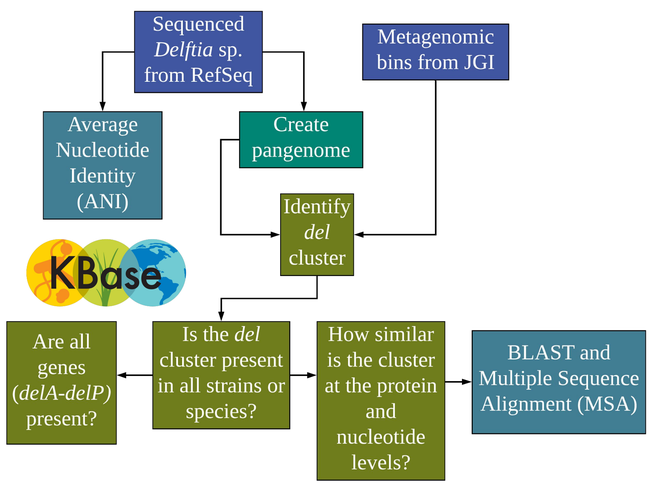


Figure 2. Different genomes of *Delftia* species were compared in KBase to identify and compare the *del* cluster across the genus and between *Delftia* genomes only identified at the genus level. Further analysis was performed to identify the *del* cluster within metagenomic assembled genomes (MAGs) to investigate the presence of the *del* cluster across different environments[3].

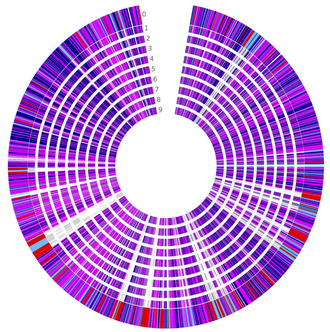
Results

Average Nucleotide Identity

Query Genome	Reference Genome	ANI
Delftia acidovorans NBRC 14950	*Delftia acidovorans* 2167	99.998
D. tsuruhatensis NBRC 16741	*D. lacustris* LMG 24775	98.3373
Delftia spp. ZNC008	*D. lacustris* LMG 24775	98.1463
D. acidovorans NBRC 14950	*D. acidovorans* SPH-1	97.5302
D. acidovorans 2167	*D. acidovorans* SPH-1	97.5098
D. tsuruhatensis NBRC 16741	*D. acidovorans* SPH-1	95.5255
D. lacustris LMG 24775	*D. acidovorans* SPH-1	95.391
Burkholderia cenocepacia	*D. acidovorans* SPH-1	76.81

Table 1. *Delftia* species genomes are very similar, they all fall above the 95% ANI cutoff to be considered the same species. KBase was used to generate ANI values.

Delftia Pangenome



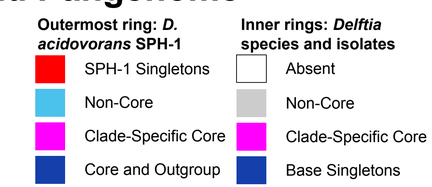


Figure 3. A pangenome comparing *D. acidovorans* SPH-1, *D. lacustris*, *D. tsuruhatensis* and a series of *Delftia* species found that the *del* cluster was present in the clade-specific core across the genus. The *del* cluster was absent in the outgroup, *Cupriavidus metalliudrans*[4].

Species	Genome contains the *del* cluster	Percent Identity of *delE*
D. acidovorans SPH-1	Yes	100.0%
D. acidovorans 2167	Yes	97.4%
D. tsuruhatensis NBRC 16741	Yes	97.3%
D. lacustris LMG 24775	Yes	97.3%
Delftia sp. ZNC008	Yes	96.9%
Cupriavidus metallidurans	No	N/A

Table 2. BLASTp confirmed the similarity of the proteins produced by these genes across the *Delftia* genus[4].

Metagenomic Data Search

Four metagenomic datasets were assembled to search for *Delftia*: subsurface fracture fluid from a gold mine in South Africa, hydraulic fracture well fluid, subsurface sediment from a gas well and rice root iron plaques. Although raw reads indicated that *Delftia* was present in all four samples, *Delftia* was not present at a high enough abundance to assemble a full genome. A workflow was produced in KBase for future replicates[4].

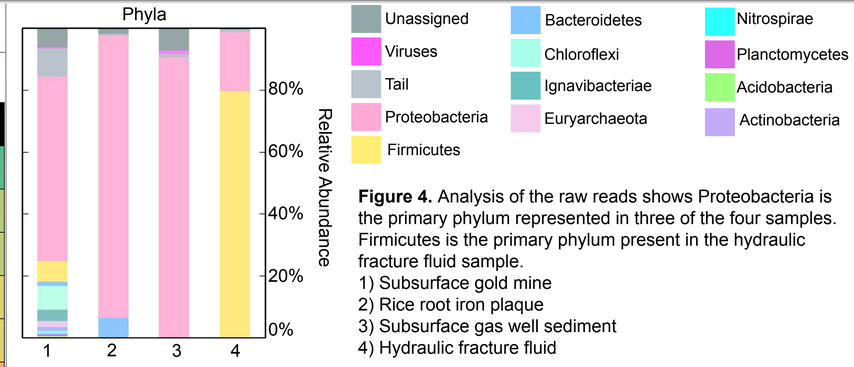
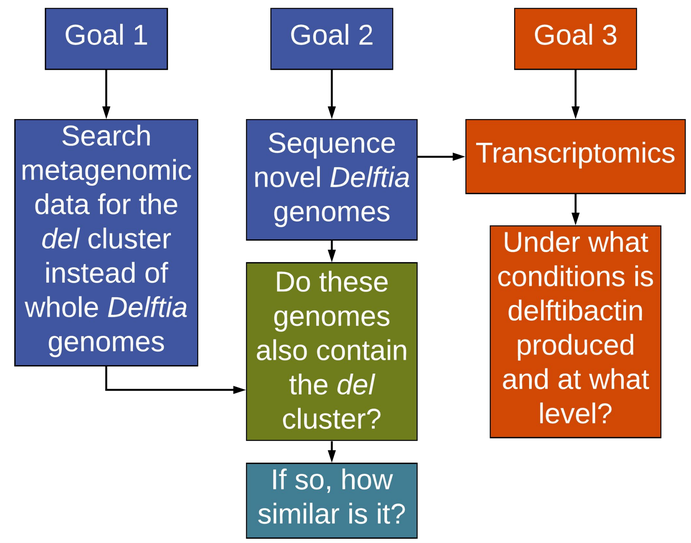


Figure 4. Analysis of the raw reads shows Proteobacteria is the primary phylum represented in three of the four samples. Firmicutes is the primary phylum present in the hydraulic fracture fluid sample.
1) Subsurface gold mine
2) Rice root iron plaque
3) Subsurface gas well sediment
4) Hydraulic fracture fluid

Conclusions

- *Delftia* species are very closely related and could potentially be considered the same species since they have average nucleotide identities of over 95%.
- The *del* cluster is present throughout the *Delftia* genus.
- Some assembled genomes contained gaps within the *delG* and *delH* genes. Both *delG* and *delH* have high GC content over 70%, and *delH* contains a number of short palindromes that may hinder sequencing & assembly of these regions.

Future Directions



References

1. Johnston, C., Wyatt, M., Li, X. et al. Gold biomineralization by a metallophore from a gold-associated microbe. *Nat Chem Biol* **9**, 241–243 (2013). https://doi.org/10.1038/nchembio.1179
2. Tejman-Yarden, N., Robinson A., Davidov, Y. et al. Delftibactin-A, a non-ribosomal peptide with broad antimicrobial activity. *Front Microbiol* **10**, (2019). 10.3389/fmicb.2019.02377
3. Created with LucidChart (www.lucidchart.com)
4. Created in KBase (http://kbase.us/)

Acknowledgements

We would like to acknowledge Dr. James Counts, Dr. Jason Whithman and the KBase helpdesk for their help and support with this project. We would also like to acknowledge Lauren Ramillo for creating the delftibactin and *del* cluster graphics included in the introduction of this poster.