Geographic Mapping of Ultramafic Rock Samples from New Guinea and Applications to Arc-Continent Collisions and Earth's Long-Timescale Climate

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Research Experiences for Community College Students

Background

- On a timescale of millions of years, Earth's climate is balanced by the geological processes of volcanism and the chemical weathering of silicate rock. [1]
- Global weatherability is directly related to periods of global glaciation and cooling.[2]
- Factors that increase weatherability are warm temperatures, moisture, surface area exposure, and mafic rock composition (Mg2+ rich). [1]
- 10-20% of of land area is responsible for ~ 50-75 % of CO2 consumption trough silicate weathering. [1]
- Arc-continent collisions expose oceanic lithosphere to the surface (ophiolites) during orogenesis.
- Sutures in the tropical rain belt provide visual reference to past glaciation, correlating suture length to glacial period.
- Geological data coupled with paleogeographic reconstruction can be used to estimate changes in topography and lithology within the tropical rain belt through time.
- The tropical rain belt is confined below the Hadley circulation; the tropics have stayed relatively warm and wet throughout time.

Methods

- Geographic data was collated for a set of Irian Jaya ophiolite samples from the central range in western New Guinea.
- The information connected to the ophiolite samples included latitude and longitude coordinates, lithology of source rock, and in some cases, the metamorphic age of the sample as estimated using potassium-argon dating techniques.
- In ArcGIS Pro, our historic map was assigned geographic metadata by registering control points by hand, and then transformed as a 1st Order Polynomial (Affine) with RMS error <1.

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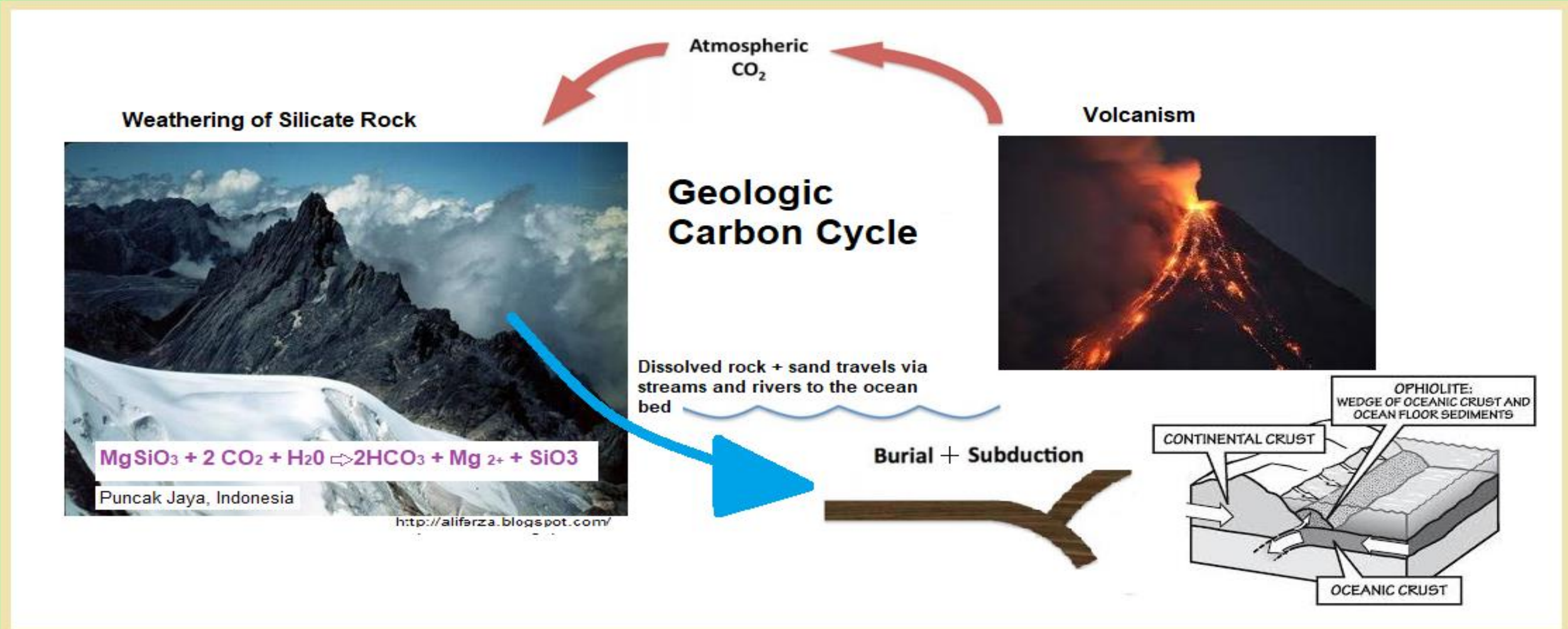


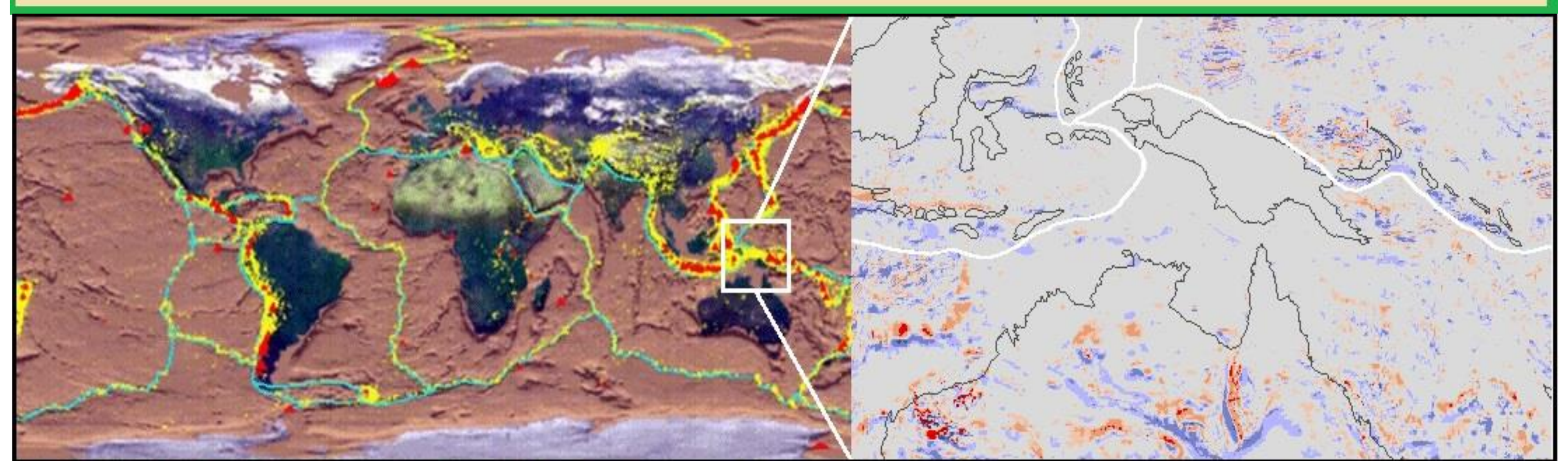


Plate Margins (blue lines), Active Volcanoes (red triangles), Earthquake epicenters (yellow dots)
Primordial Hydrogen-Helium Degassing - A Major Source for Internal Terrestrial Processes
Arie Gilat and Alexander Vol; HAIT Journal of Science and Engineering B - Vol 2 - Issues 1-2, 2005

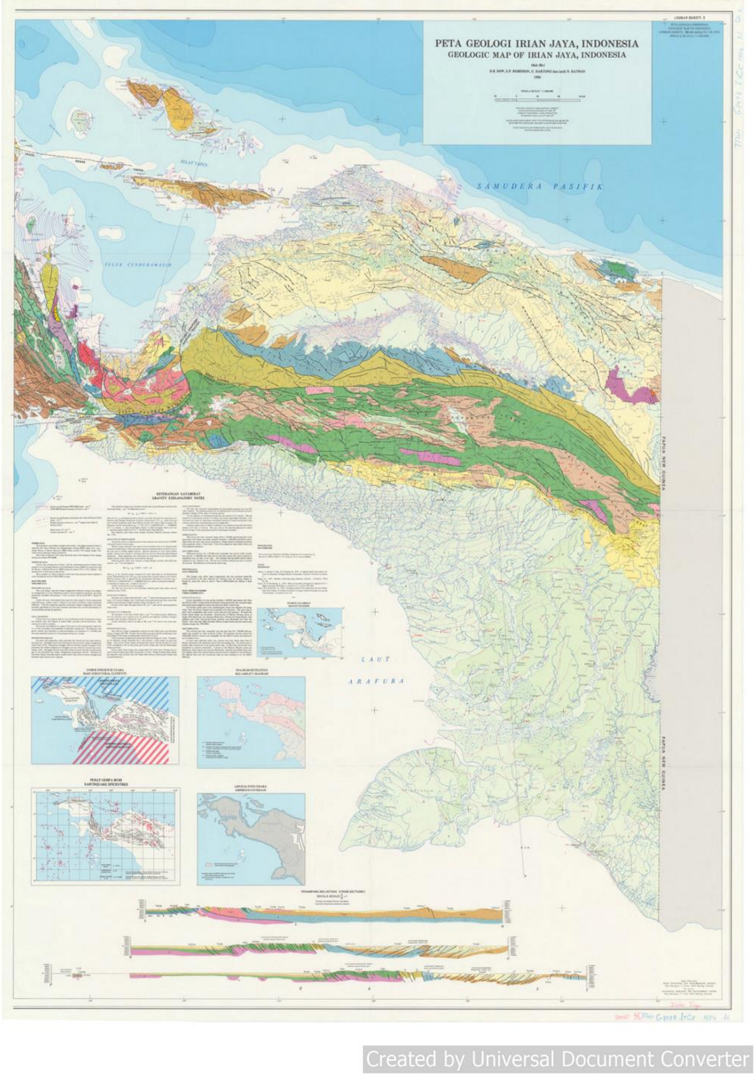
New Guinea is unique in its proximity to diverse tectonic activity and its capacity to sequester CO_2 through weathering. Image: ArcGIS Living Atlas - Tectonic Plate Boundaries and Magnetic Anomalies

Purpose

The purpose of this project was to create a map that would improve our understanding of the latitudinal distribution of ultramafic rock samples to be cross-referenced with thermochronology data.

Additionally, an historic geological map of the region was georeferenced in ArcGIS Pro, adding it to the global geographic information system for future spatial analysis projects.

Priority	Sample Name	Long	Lat	Metamorphic Age
1	94TM-DB1A	138.619	-3.3695	35.1+/-0.8 (hlb K/Ar) 26.2+/-0.5 (bt K/Ar)
2	93RW18	138.66	-3.345	23.7+/-0.6 (hlb K/Ar)
3	95RW07	136.6533333	-3.217	10.8+/-0.8 (hlb K/Ar)
4	95RW08	136.6566667	-3.212	10.7+/-1.5 (hlb K/Ar)
5	95RW05	136.6531667	-3.22267	10.9+/-1.5 (hlb K/Ar)
6	95RW04	136.6531667	-3.19967	12.1+/-1.5 (hlb K/Ar) 9.7+/-0.2 (bt K/Ar)
7	95RW38	137.3626667	-3.64217	46.0+/-1.1 (whole rock K/Ar) 21.3+/-0.4 ("white mica" K/Ar")
8	FI4020A	138.75	-3.61	31.6+/-0.7 (hlb K/Ar) 29.4+/-0.9 (bt K/Ar)
9	94RW30	137.4021667	-3.67667	61.5+/-1.3 (whole rock K/Ar)
10	95RW61	138.5076667	-3.50767	40.4+/-0.9 (Whole rock K/Ar)
11	95RW62	138.5173333	-3.51733	
12	93RW14A	138.66167	-3.43167	35.4+/-4.4 (hlb K/Ar)
13	93RW14B	138.66167	-3.43167	
14	95RW00	137.506167	-3.412	57.9+/-3.7 (hlb K/Ar)
15	94TM-DB1B	138.619	-3.3695	
16	94TM-DB2	138.619	-3.3695	
20	93RW16A	138.57	-3.42167	
21	93RW16B	138.57	-3.42167	
22	93RW17	138.5733333	-3.42333	
23	93RW19	138.6616667	-3.34833	23.7+/-0.7 (hlb K/Ar)
24	94RW21	137.4445	-3.7305	915+/-15 ("white mica" K/Ar)
25	94RW23	137.4636667	-3.7605	30.8+/-0.7 (whole rock K/Ar)
26	95RW15	136.6615	-3.39617	
27	95RW31A	136.6671667	-3.38833	
28	95RW31B	136.6671667	-3.38833	
29	95RW39	137.3598333	-3.63983	69.6+/-1.5 (Whole Rock K/Ar)



Results

Fig 1. ArcGIS satellite imagery base map, coordinates uploaded as csv document and mapped as 40% transparent pink diamonds. Deeper shade indicates denser sample population

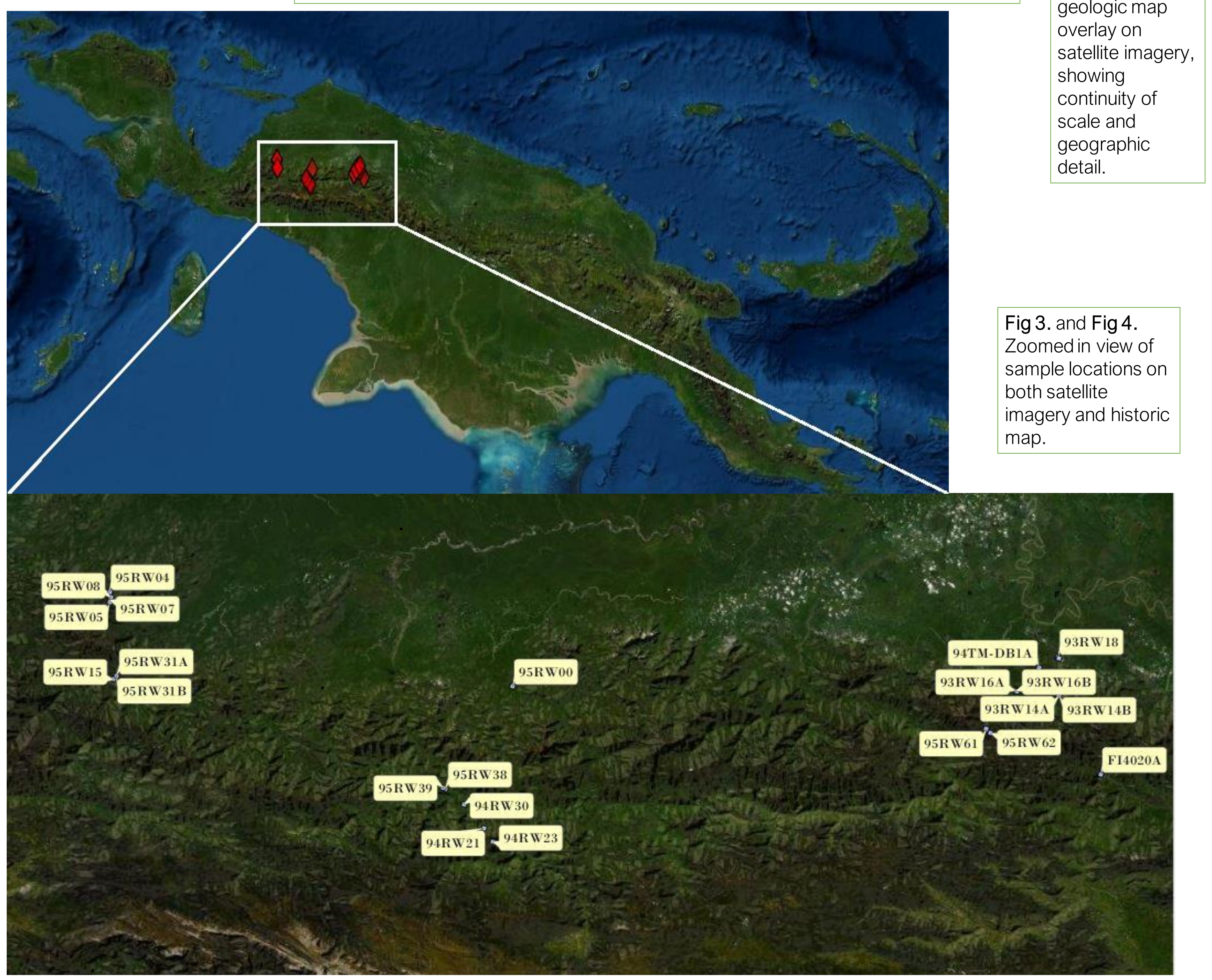


Fig 2. Historic geologic map overlay on satellite imagery, showing continuity of scale and geographic detail.

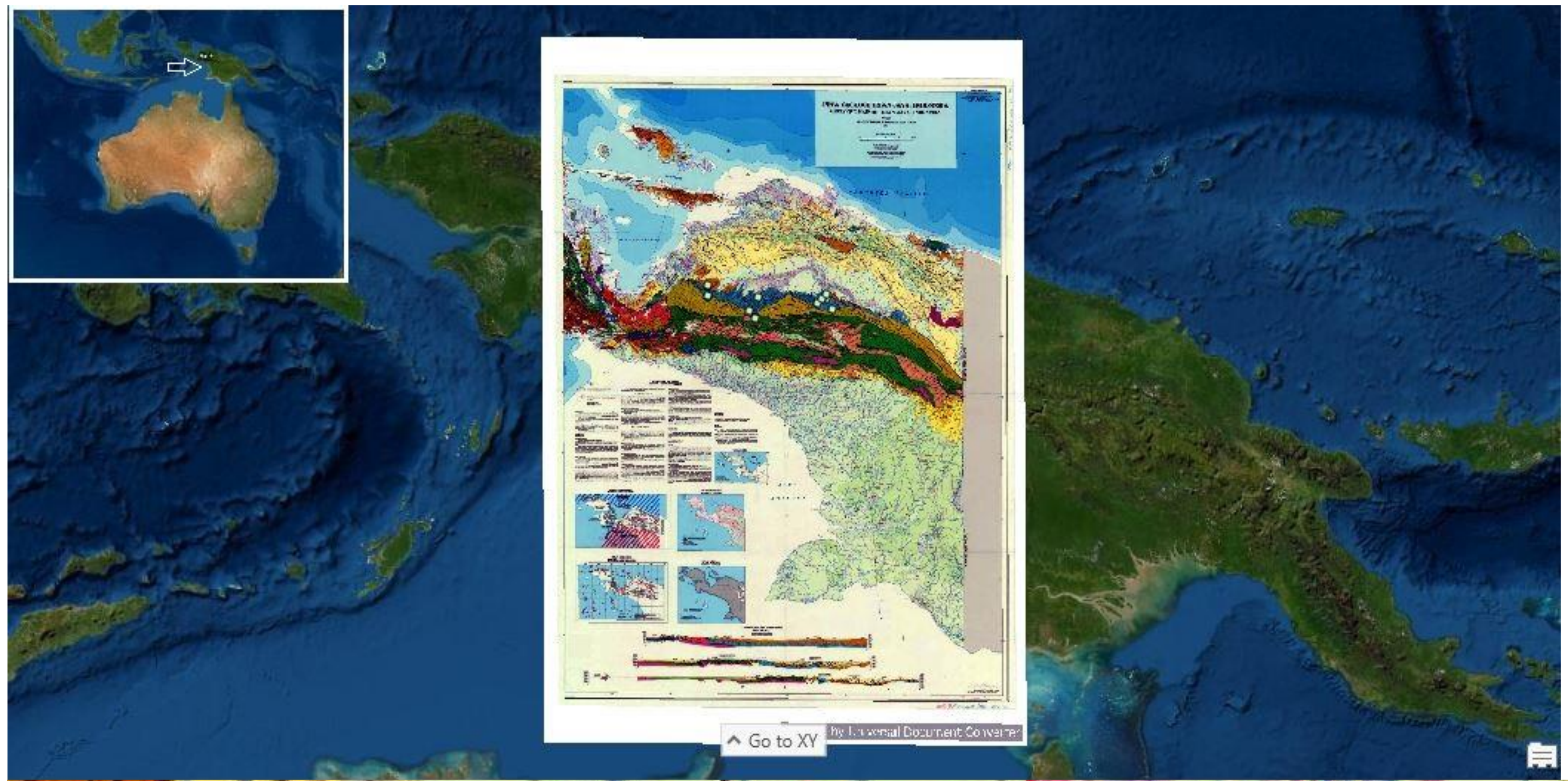
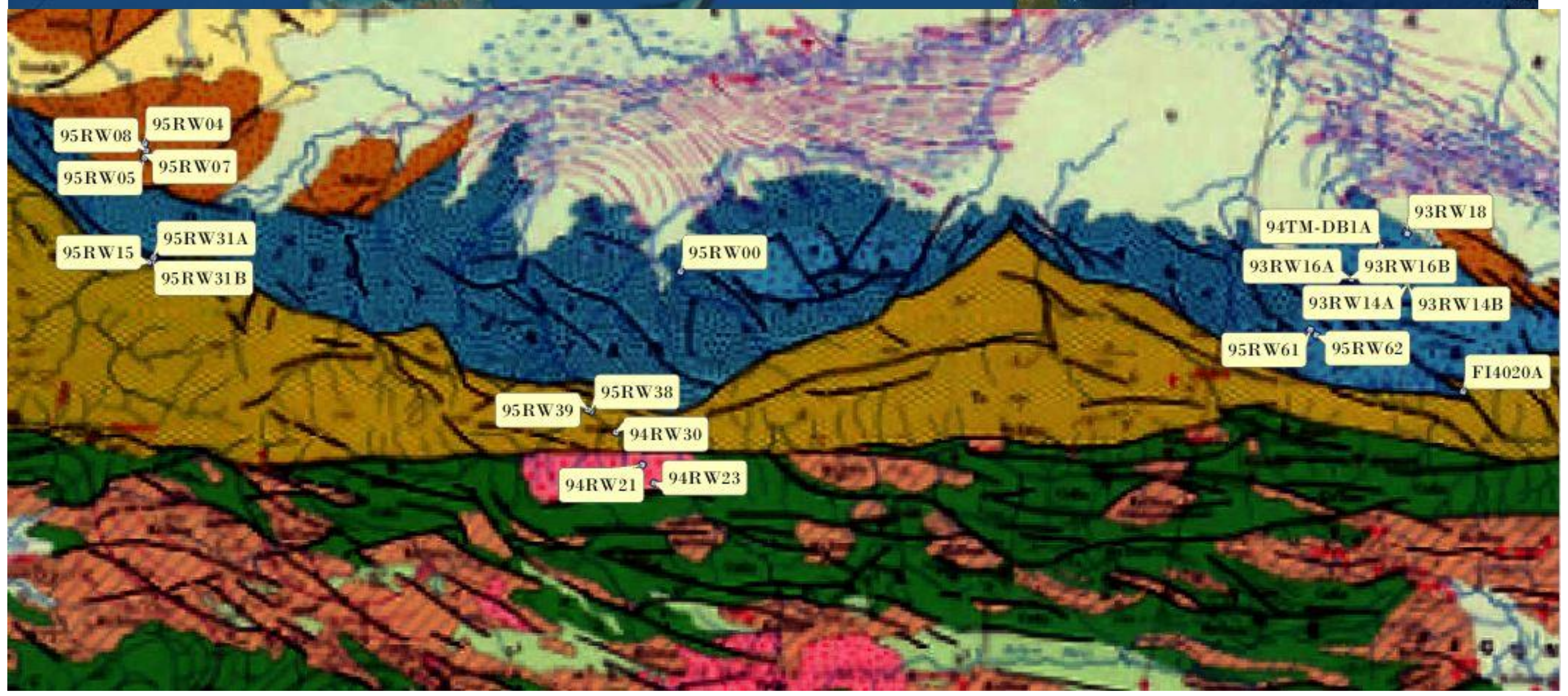


Fig 3. and Fig 4. Zoomed in view of sample locations on both satellite imagery and historic map.



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4. TECTONICS OF THE NEW GUINEA REGION
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