Murujuga (which means "hip bone sticking out" in Ngarluma-Yaburara language) is in the coastal Pilbara region of Western Australia.

With over one million recorded petroglyphs (rock art), it is home to one of the largest, densest and most diverse collections of rock art in the world.

The rock art is of continuing cultural and spiritual significance to the Traditional Owners. It also has significant state, national and international heritage value.

The Government of Western Australia is committed to the ongoing protection of Murujuga's rock art. The Department of Water and Environmental Regulation (the department), in partnership with the Murujuga Aboriginal Corporation, representing the Traditional Owners and Custodians of Murujuga, is overseeing the Murujuga Rock Art monitoring program. The monitoring program will provide knowledge to help protect and manage this significant and important area.

We're working for Western Australia.

WHERE TO FIND MORE INFORMATION

The Murujuga Rock Art Strategy is available on the department's website (www.wa.gov.au/service/aboriginal-affairs/aboriginal-heritage-conservation/program-murujuga-rock-art).

Information on the monitoring and analysis of Murujuga's rock art will be published on the Murujuga Aboriginal Corporation's website (www.murujuga.org.au) and the department's website.

The department would like to thank the Murujuga Aboriginal Corporation for providing permission for the publication of their photographs.

Government of **Western Australia**
Department of **Water and Environmental Regulation**

MURUJUGA ROCK ART MONITORING PROGRAM

MURUJUGA Aboriginal Corporation
Stories from the Stones

AUGUST 2021

CONCEPTUAL MODEL

The Department of Water and Environmental Regulation recognises the Traditional Owners and Custodians of Murujuga; the past, present and future generations of Ngurra-ra Ngarli and their ongoing connection to this sacred country.

ROCK ART MONITORING PROGRAM

As well as culturally significant rock art, Murujuga is also home to industry that contributes significantly to the local, state and national economy and employment. Concern that the rock art could be damaged by industrial air emissions has led to a number of independent scientific studies and rock art monitoring since the mid-2000s.

Recent independent reviews identified several improvements that could be made to the rock art monitoring, to provide more reliable information about the impacts of air emissions on the rock art. In 2019 the department released the Murujuga Rock Art Strategy (the strategy), which aims to protect Murujuga's rock art through improved monitoring, analysis and management.

As part of the strategy, the department and Murujuga Aboriginal Corporation are creating a world's best practice monitoring program that will help us to understand if the rock art is being impacted by human activities. The outcomes of the monitoring program will help us to look after the rock art in the future. A critical first step in the monitoring program is developing conceptual models of the rock art system.

CONCEPTUAL MODELS

Conceptual models help to explain complex systems and inform their monitoring programs. Using what we already know about rock art on Murujuga and in other parts of the world, we have developed a set of conceptual models that:

- outlines our current understanding of the Murujuga Rock Art system
- informs monitoring studies of the rock art
- informs the development of an Environmental Quality Management Framework.

The conceptual models are an important communication tool. We will update them as we learn more about the rock art system from the monitoring studies.

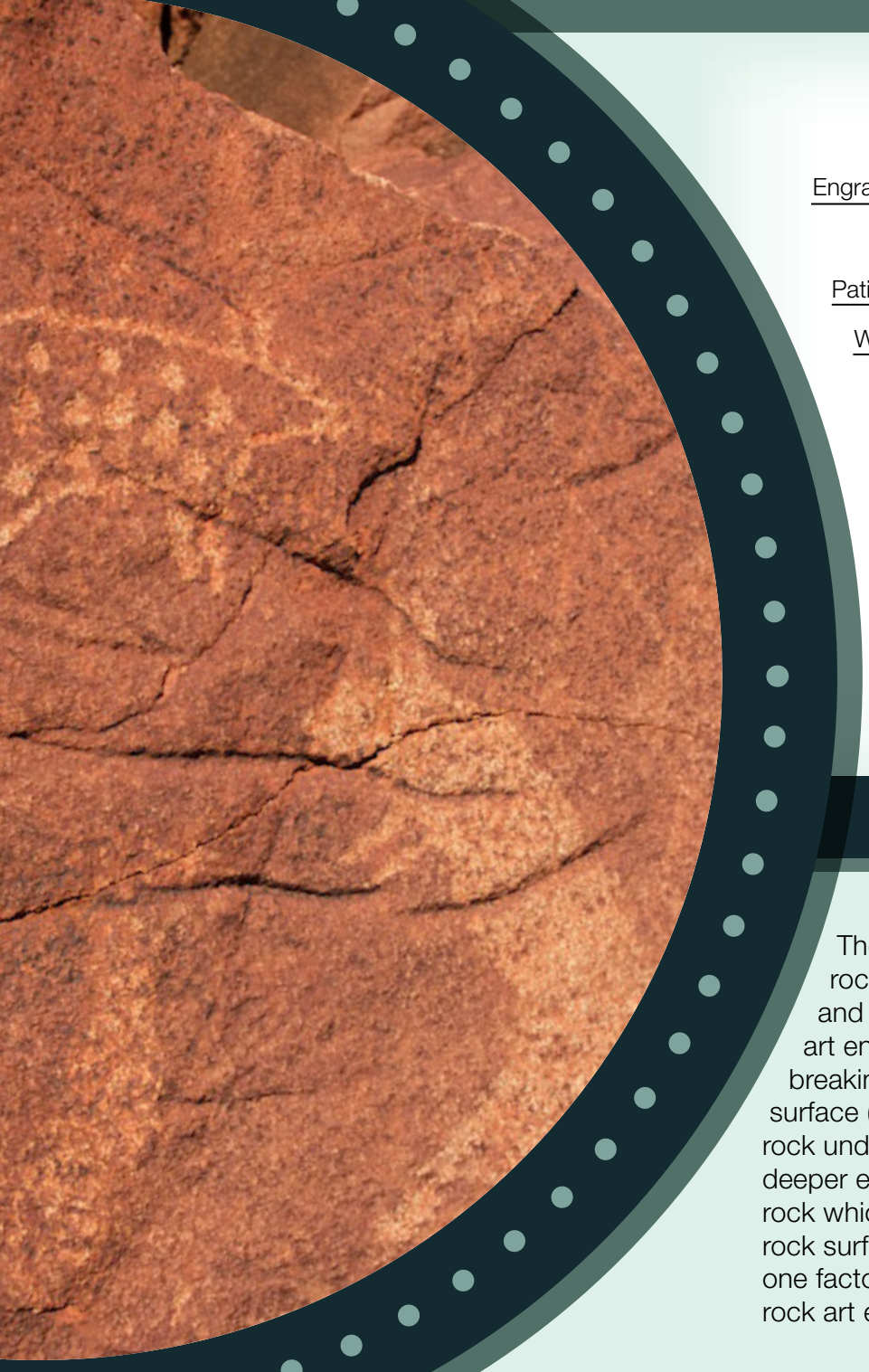
The initial conceptual models consist of the following three models:

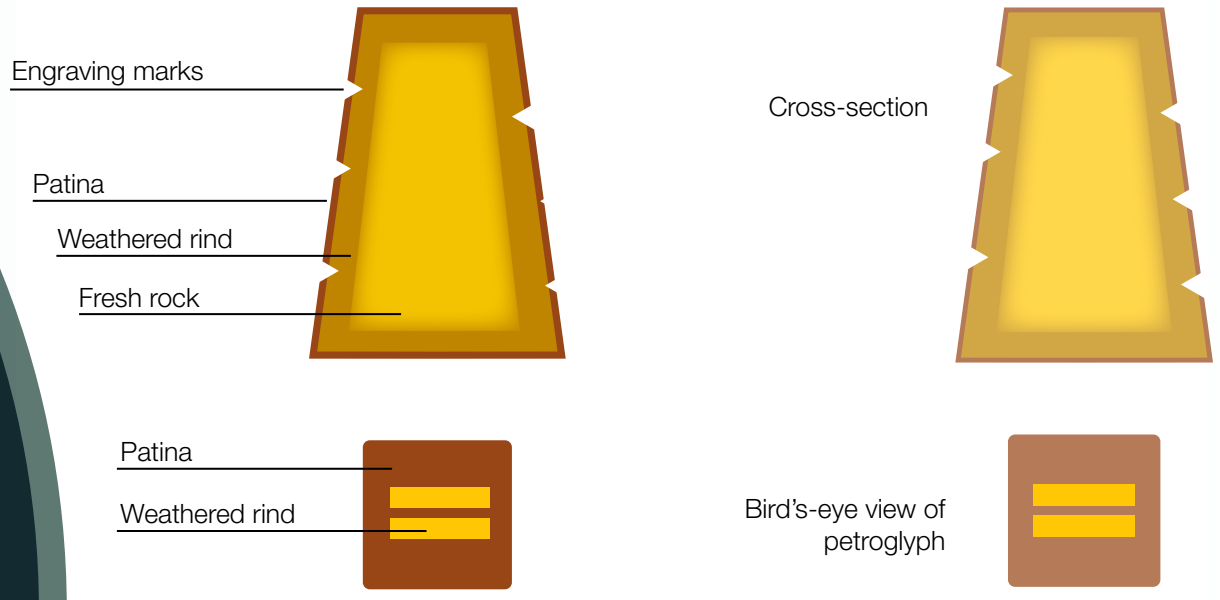
- Framework model
- Stressor model
- Pressure-response model and narrative.

The **framework model** describes the potential interactions occurring on the rock surface that will be considered through the monitoring program. The **stressor model** identifies sources of air emissions which can lead to changes to the quality and colour of the rock art.

This brochure introduces the **pressure-response model**, which is designed to help explain how environmental pressures can affect processes that occur on the rock surface and may lead to changes in the rock art condition.

Our key interest in the monitoring program is to learn if human activities are causing a decline in the condition of the rock art.





EXAMPLE OF ROCK ART WEATHERING

The diagram above shows how the rock art on Murujuga was created and how it weathers over time. A rock art engraving (petroglyph) is formed by breaking through the naturally formed rock surface (patina) to expose lighter-coloured rock underneath (weathered rind). Some deeper engravings may expose the fresh rock which is usually darker than the rock surface. These colour contrasts are one factor that informs the condition of rock art engravings.

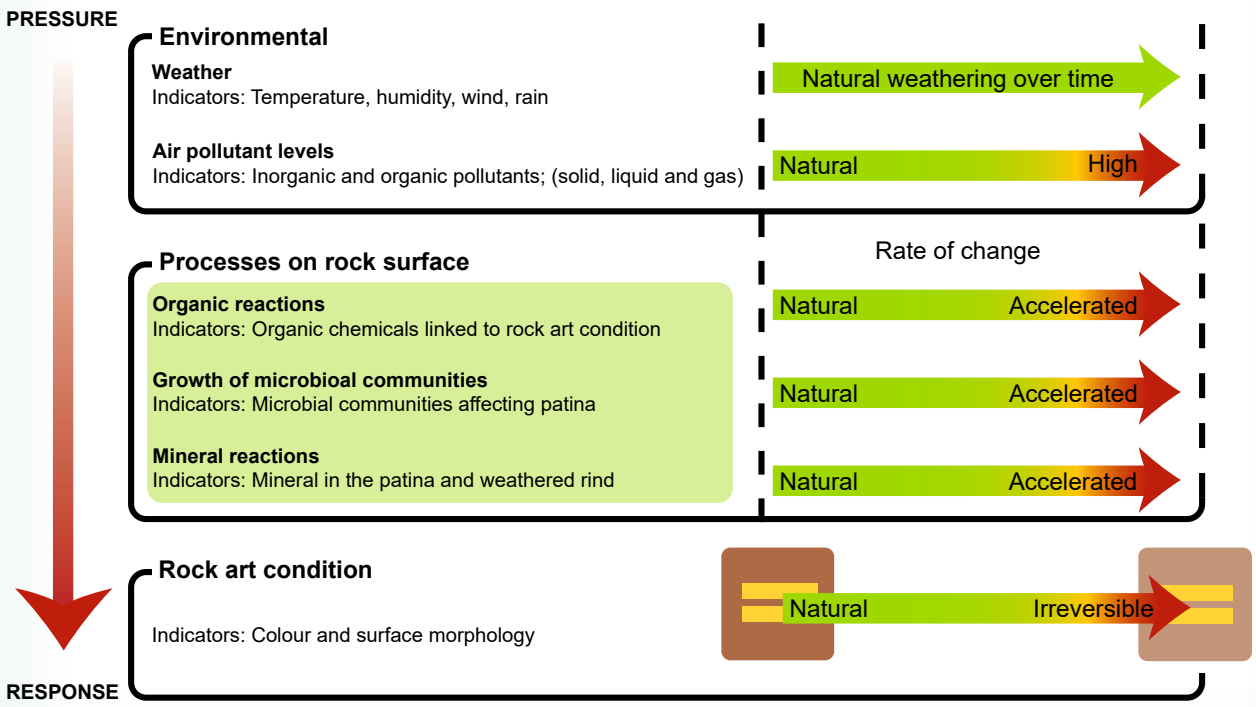
The rock art images can fade over time from natural weathering, as well as weathering that has been accelerated as a result of human activities. The monitoring program aims to determine how much change (if any) may be because of human activities.

PRESSURE-RESPONSE MODEL

The surface of the rock represents a dynamic system that has evolved over thousands of years.

Environmental pressures:

Natural pressures include those from sources such as gases from plants, dust (e.g. from the land) and bushfires. Anthropogenic pressures include those from human activities such as industry, shipping, traffic and tourism. Potential pollutants include different types of chemicals in either solid, liquid or gas form that are carried across the Murujuga area by the wind (dispersion) and deposited on to the rock surfaces.



Processes on the rock surface:

There are a number of processes taking place on the rock surface, which are connected to each other:

- **Organic compounds** from the air combine with natural organic compounds released from the rock. This provides a food source for organisms living on the rock, which changes the growth of microbial communities.
- **Microbial communities** such as bacteria and fungi contribute to the creation of a biofilm and the coloured patina. The rate of growth of different microbial communities will affect the rock surface in different ways and may produce chemicals that dissolve the patina.
- **Exposure to air pollutants** can change the types of minerals present on the rock surface, which affects chemical reactions and microbial communities and may increase the rate of weathering.

The green ends of the arrows represent natural processes and red indicates an increased rate of weathering.

Rock art condition:

The environmental pressures and processes on the rock surface combine to determine the overall condition and appearance of the rock art.

This can affect the colour contrast on the rock, which is critical to the visual appearance of the rock art engravings (petroglyphs). Natural weathering processes and seasonal changes in microbial communities can cause colour variations and changes to the condition of the rock surface.