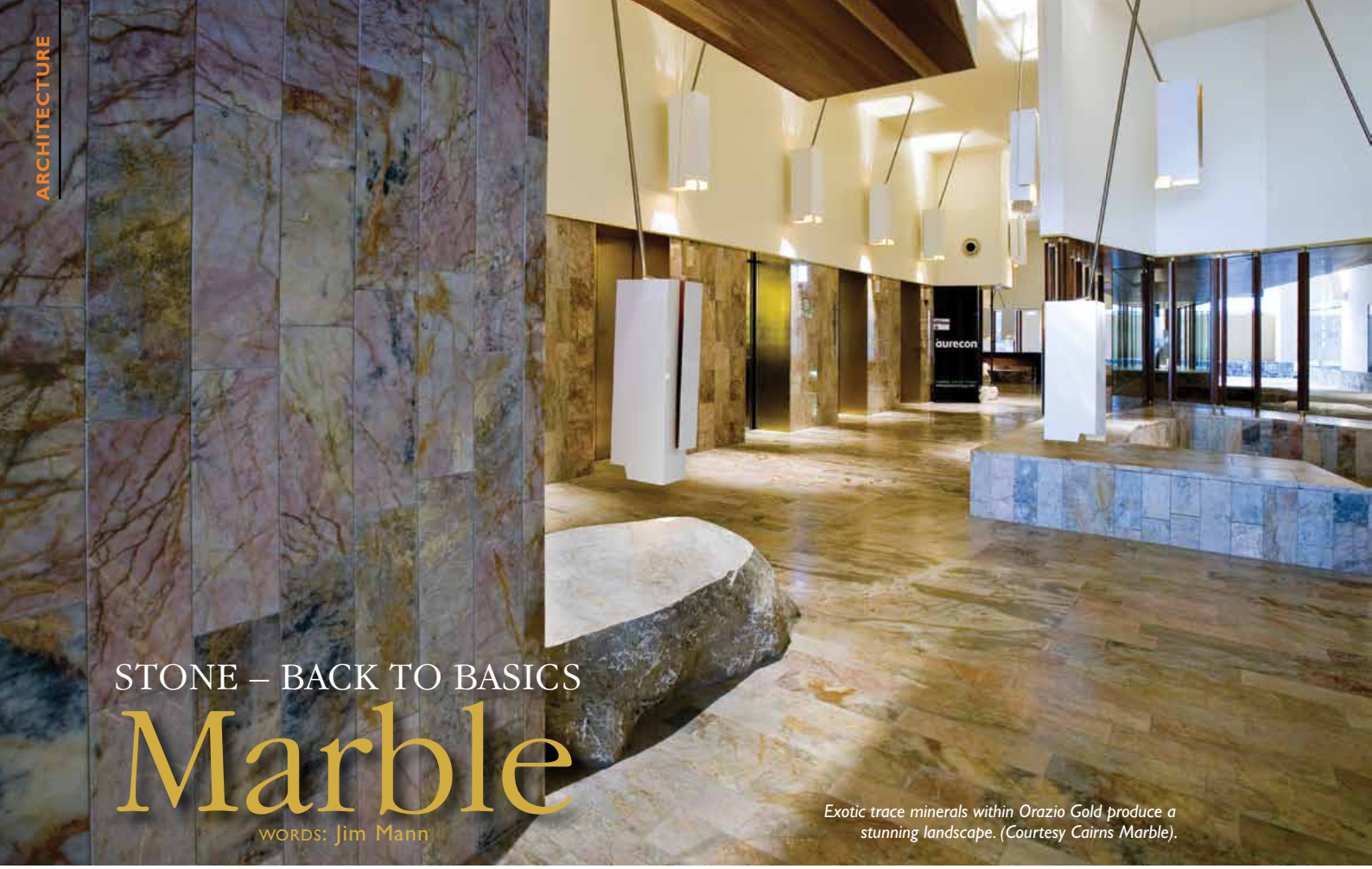



Exotic trace minerals within Orazio Gold produce a stunning landscape. (Courtesy Cairns Marble).

STONE – BACK TO BASICS

# Marble

WORDS: Jim Mann

*Marble has been synonymous with prestige and elegance for thousands of years and Australia is now witnessing a resurgence in its use for both interior and exterior applications. The subtle colours and delicate figuring that are characteristic of marble give it the versatility to be used as either a minimalist backdrop or a high-class statement. So what is this timeless stone?*

## The Relationship between Marble and Limestone

As discussed in an earlier 'Back to Basics' article regarding limestone, the relationship between marble and limestone is complex (if not ambiguous). While both stone types are composed predominantly of calcite and/or dolomite, their structure and properties are quite different. Limestone is a sedimentary stone type that is formed by the deposition of small fragments of coral, shells and other marine organisms that undergo dewatering, compaction and cementation through pressure applied by the overlying sediment.

Marble could be called a 'next generation' rock, as it is formed by exposing the sedimentary limestone to high pressure that occurs due to the rock's deep burial within the earth, applied forces through tectonic movement (e.g. Carrara marble deposit) and/or high temperatures from contact with molten rock intrusions (e.g. Chillagoe marble). This process is known as metamorphosis and results in the recrystallisation of the minerals present. The recrystallisation also obscures most of the previous features (e.g. shell fragments) and textures (e.g. bedding) producing a product that does not have a noticeable rift or 'grain'. Crystal sizes vary from very fine-grained material such as Statuario, where the grains can be less than 1mm in size, to coarse-grained material (>10mm) such as Crushed Ice from northern Queensland.

Compared to its parent rock, marble is less porous, which allows it to be polished. In a commercial sense, limestone and marble are visually differentiated by the level of polish that can be achieved. If the stone can achieve a high polish then it is usually sold as a marble, if not, it is likely to be sold as limestone.

In trying to determine if a stone is a limestone or marble it is important to remember that marble is a metamorphic rock and fossil fragments are converted into calcite crystals which removes any trace of the original structure. The fracture face of a marble tile will also be 'sugary' with uniform grain size, while a limestone may show remnants of the original sediment.

## Appearance

Marble typically has a white background colour with bands, streaks or swirls of other colours that vary depending on the type of trace minerals present. White marble such as Calacatta is composed of nearly 100 per cent calcite, while other popular marble types such as Bianco Carrara contain a significant proportion of dolomite, which produces the wispy grey bands through the stone. The

*Marble kitchen benches and splash backs (Courtesy CDK Stone)*

variable chemistry of dolomite can also lead to the formation of marble with colours ranging from yellow to red to dark brown. Organic impurities can produce marble that is black, while the presence of chlorite can impart a green colour.

Brecciated marble types such as Arabescato are striking in appearance and are formed after the rock has been subjected to a second form of metamorphism that has broken up the marble into angular fragments (breccia) and recemented together by finer calcite-rich material.

## Use

Marble is a highly versatile stone type as it can be cut and ground to a high polish. It is suitable for processing into cubic form, as well as panels for internal or external wall cladding, and can be calibrated into thin tiles for walls and floors. The low hardness, absence of a 'grain', and characteristically fine grain size make the stone suitable for carving into intricate statuary.

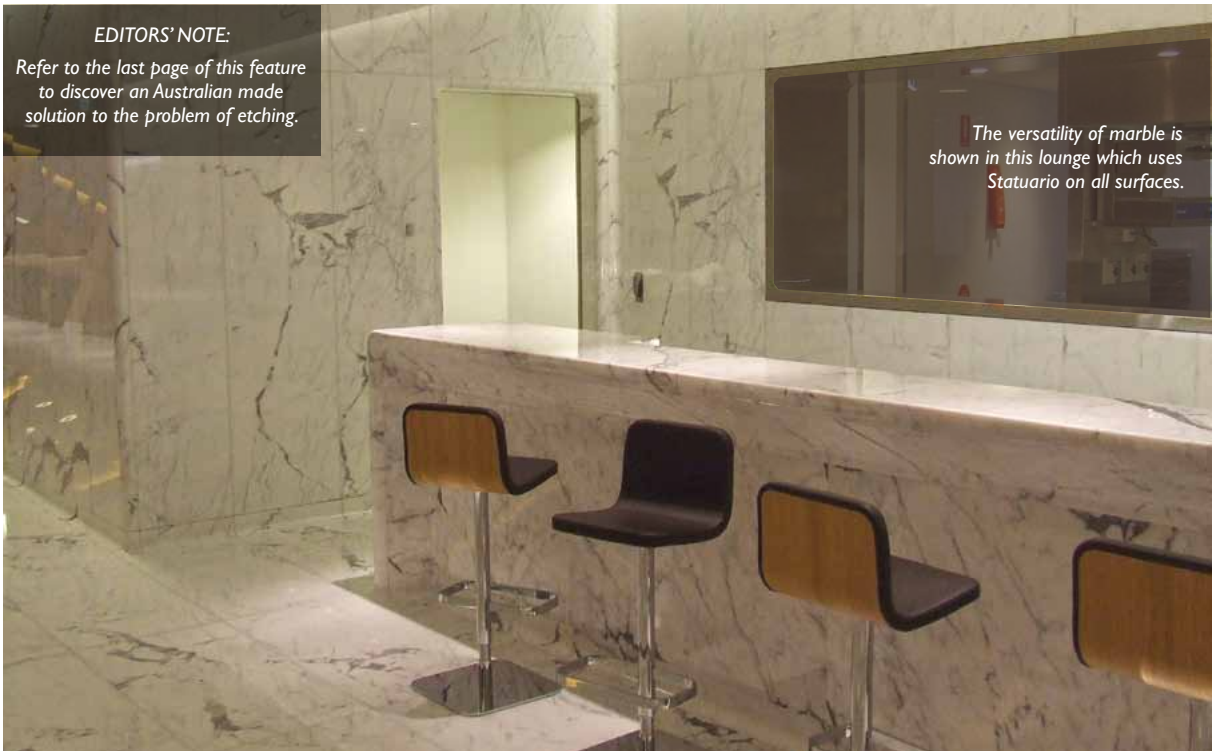
## Design Considerations

Marble is predominantly composed of calcium carbonate, which can be etched by acidic substances such as wine, soft drinks and some liquid soap. Pure fine-grained calcite marbles are particularly vulnerable to etching due to the greater concentration of grain boundaries which are exposed to acid attack. Dolomite is less soluble in acid than calcite, meaning dolomitic marble is slightly less prone to etching. If the stone is likely to be exposed to acids, the use of a honed or matt surface will make etching less conspicuous. It is important to note that the application of an impregnating sealer will not prevent etching as these sealers do not protect the surface of the stone.

Occasionally marble is known to develop irregular pale yellow/brown stains caused by the deposition of soluble iron from the natural (quarried) moisture in the stone. This discolouration is difficult to predict, and it can seriously detract from the appearance of the stone. The best way to

*EDITORS' NOTE:*

*Refer to the last page of this feature to discover an Australian made solution to the problem of etching.*



*The versatility of marble is shown in this lounge which uses Statuario on all surfaces.*

*Thermal Hysteresis occasionally occurs when marble is used as an external cladding material. Jim Mann explains this phenomenon and the steps that should be taken to avoid it. Pictured, the new marble façade on Finlandia Town Hall – approximately 6 months after a recladding of the building*

try to avoid this distressing phenomenon is to ensure the stone comes from a quarry and bench that is known to produce quality stain-free stone.

Marble has a relatively low abrasion resistance, which can lead to loss of polish in high-traffic areas. Although marble can be prepared in a wide range of surface finishes from polished to grit blasted, the low hardness and fine-grained nature of marble can present some limitations with regards to slip resistance as T calcite grains tend to become rounded instead of presenting a rough textured edge, which would otherwise provide mechanical grip.

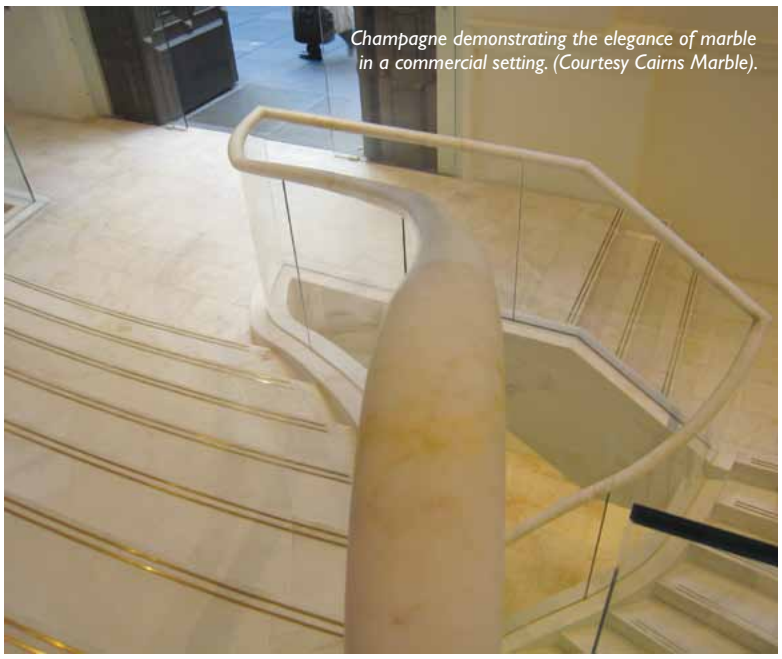
Most 'true marble' is not moisture sensitive and is suitable for use in bathrooms. Some stone types marketed as 'green marble' contain a mineral known as serpentine and are known to be dimensionally unstable and unsuitable for wet areas and need to be installed with specialty adhesives.

## Thermal Hysteresis

The reputation of marble for use as external veneer cladding has been dealt a blow in the past due to the warping of panels on some prominent projects such as the Amoco Building in Chicago. This permanent warping phenomenon is known as thermal hysteresis. Hysteresis is defined as "a lag in the return of an elastically deformed body to its original shape after the load has been removed". For marble the deformation is primarily due to cyclic heating and cooling from the sun, which is exacerbated by cyclic wetting and drying.

When a marble panel is fixed to a façade the external face is heated and expands relative to the internal face which causes minor, warping (usually not detectable). As the outer face cools, the panel should return to its original shape but in some types of marble the dislocated grains become interlocked, causing permanent deformation. The cyclic heating and cooling leads to an incremental increase in the dislocation and warping, which causes an increase in porosity and subsequent loss of strength. This can eventually lead to a catastrophic failure.

It is important to note that not all marble is sensitive to thermal hysteresis. The exact cause of hysteresis is a complex issue and the likelihood of it occurring depends on a broad range of issues. Fine-grained marble with irregular interlocking grains have been found to be more sensitive to the development of hysteresis. Locations with extreme



*Champagne demonstrating the elegance of marble in a commercial setting. (Courtesy Cairns Marble).*

temperature variations in conjunction with regular wetting and drying are considered high-risk areas for marble veneer. In general, the risk of panels warping can be reduced by increasing the panel thickness (thereby making the panel stiffer) and minimising the length-to-width ratio to reduce the apparent warping within the panel.

## Testing and Specification of Marble

Standard specification ASTM C503 provides a guide to the selection of marble dimension stone suitable for general building and structural purposes. The standard provides some separate requirements for calcite and dolomitic marble. The physical requirements for this specification are given in **Table 1.**

Table 1. ASTM C503-10 physical requirements of marble dimension stone.

| PROPERTY | MARBLE |
|---|---|
| Bulk Specific Gravity – min (kg.m-3) | |
| Calcite | 2600 |
| Dolomite | 2800 |
| Water Absorption – max (% by weight) | 0.20 |
| Modulus of Rupture – min (MPa) | 6.9 |
| Flexural Strength – min (MPa) | 6.9 |
| Compressive Strength – min (MPa) | 52 |
| Abrasion Resistance – min (Ha) | 10 |

The specification of any dimension stone should be based on location, design and engineering considerations specific to the intended use. The specification states a minimum strength requirement that calls for the determination of both dried and soaked strength although there is not usually a significant difference between these values for 'fresh' marble.

Water absorption and flexural strength are the key performance indicators for this stone and should be evaluated closely throughout the project supply phase to ensure adequate performance in service.

## In Summary

Marble is a versatile stone type that is suitable for nearly all locations. Taking note of the following points will assist you in selecting the right stone for the job, and maintaining it well into the future:

- Use water absorption and flexural strength tests as key performance indicators.
- If the stone is to be used as external cladding, evaluate the risk of thermal hysteresis on a project-by-project basis.
- Be aware that some loss of polish and change in slip resistance properties may occur in high-traffic areas.
- Marble is acid sensitive, so to avoid permanent staining and etching, it is important to clean up spills immediately.
- If you are using a 'green marble' ensure the stone is dimensionally stable and install it accordingly. DS