



# Zeolite — a multi-talented environmental solution

The recent discovery of natural zeolite deposits in Australia has led to the increasing awareness and use of these minerals to eliminate, or at least reduce, many long-standing environmental, agricultural and industrial pollution problems.

Natural zeolites are safe, environmentally friendly, naturally occurring minerals that are aluminosilicates and have an open box-work crystal structure which is occupied by cations and water molecules. These ions and water molecules can move within the large cavities allowing ionic exchange and reversible rehydration.

These features mean that they are useful in solving many environmental problems including offensive odours and heavy metal contamination. Natural zeolites also have the ability, due to their high cation exchange capacity, to absorb plant nutrients and improve fertiliser efficiency.

## Turning waste into valuable fertiliser

In 2003, a property called 'Gowrie' conducted a field trial using the wheat variety 'Sunlin'. Sample area 1 had a base application of artificial fertiliser but no zeolite and pig manure, and yielded an average of 5.1 t/ha. Sample area 2 was treated with additional zeolite and pig manure, and yielded 7.4 t/ha. The individual samples taken are shown in Figure 1.

### How it works

Zeolites have a strong affinity for ammonia ( $\text{NH}_4^+$ ) and store it up instead of allowing it to volatilise. The ammonium ion  $\text{NH}_4^+$  is attracted to the negative charge of the crystal. The large honeycomb crystal structure provides a huge storage space.

Treated effluent samples are very high in ammonia but low in nitrates, a big plus for the environment. Plant nutrient cations eg, potassium ( $\text{K}^+$ )



Figure 1: Wheat trial yield at 'Gowrie' 2003.

and zinc ( $\text{Zn}^{2+}$ ) are also stored in the zeolite crystal as well as water molecules. All these nutrients are readily available to the plant.

It is thought that the readily available potassium increases the plants' resistance to disease, eg, Crown rot, and improves the quality of the grain eg, Prime Hard Wheat. The ammonium ion is thought to slowly release and produce the high yield and protein at flowering time.

The black vertisol soils of Gowrie tend to tie up potassium so that fertiliser applications are not readily available to the plant. Using the zeolite as a storehouse for potassium is a real breakthrough.

## Other beneficial uses

### Liquid effluent treatment

Zeolite is an effective filter medium and can be used to remove offensive odours and dangerous heavy metals from effluent streams. It has a high affinity for ammonium and some sulfur compounds and hence is effective at reducing a wide range of offensive odours.

Zeolite also absorbs heavy metals from solution and therefore can transfer a heavy metal contamination problem of many thousands of litres of effluent to a few kilos of easily handled solid. The toxic metals are firmly held in the crystal structure and do not leach, however for ultimate environmental protection the solid zeolite can be cement stabilised or vitrified.

Examples of this application are:

- An industrial effluent that was too contaminated with lead to be discharged to the sewer was found to be better than drinking water standard after treatment with natural zeolite;
- Millions of litres of water which were contaminated with radioactive caesium after the Three Mile Island nuclear disaster were treated with natural zeolite. The caesium levels were reduced to acceptable levels and the water safely discharged.

### Sewage sludge

The ability of zeolite to absorb odours and heavy metals not only reduces the offensive nature of sewage sludge but may also almost eliminate the leaching of the contaminant heavy metals when the sludge is used as a fertiliser.

Additionally, zeolite will absorb nitrogen, phosphorus and potassium in effluents and 'slow release' them.

### Animal husbandry

Government regulations for establishing new intensive animal units are becoming more and more stringent. Natural zeolite can provide part of the solution in the approval process.



Now that NZ 76 grade zeolite powder can be used in-feed the whole process of using zeolites is easy to manage. Zeolites used 'in-feed' with ruminants greatly reduce methane emissions.

By spreading the zeolite treated animal manure over the soil, a valuable slow release fertiliser is produced. Australian irrigated wheat trials conducted in 2003 showed a very significant 2 t/ha yield increase over the control plots. These high yielding crops take up enormous amounts of nutrients as fertiliser and, as such, do not pollute the environment.

The potential is there, in the future, to cash in on carbon credits as zeolites absorb methane, carbon dioxide and carbon monoxide.

Occupational health and safety issues in regard to ammonia emissions in sheds can be addressed using 'in-feed' zeolites. Stock persons find it much better working with animals fed zeolites.



Australian trials have shown that provided shed cleanliness is maintained, adding high grade zeolite powder to the feed greatly reduces ammonia levels.

#### *Agriculture and horticulture*

Natural zeolite is a storehouse for plant nutrients and water. It is not only odourless but also absorbs odours from the environment. This characteristic makes it invaluable when mixed with all types of animal manure. Not only does it reduce odour but it takes up the plant nutrients from the manure and

slowly releases them as plants need them. Animal manure not treated with zeolites will volatilise most of the nitrogen as ammonia gas over time.

Castle Mountain sand sized zeolites have excellent watability and are suitable for lawns, gardens and pots. Natural zeolites refill with water year after year as they are inert and do not degrade in the environment, as do synthetic crystals.

The application efficiency of artificial fertilisers such as sulfate of ammonia can be improved by the addition of zeolite, as this will prevent ammonia losses to the atmosphere during spreading and incorporation.

Zeolites are a storehouse for nitrate, phosphate and potassium nutrients which are the major plant nutrients.

Minor elements like zinc are also accommodated.

#### *Aquaculture*

Modern intensive fish farming has an increasing effluent discharge problem associated with the build-up of ammonia in the tanks produced by the decomposition of excrement and/or unused food.

Castle Mountain zeolites are non-toxic to fish and, due to their cation exchange capacity, remove toxic ammonia, phosphorus and other undesirable compounds from the recirculating water of commercial fish farms.

Zeolite is also added to tank truck water and plastic bags during live fish transport to increase the stocking rate and to remove lethal ammonia.

#### *Mining industry*

Zeolite is applicable to the removal of contaminant metals from effluent mine waters. A zeolite filtration medium can reduce many millions of litres of liquid effluent to a few tonnes of safe solid waste which can be readily controlled.

Zeolite included in mine tailing can also act as a 'sentinel' by absorbing heavy metals and cyanide if and when they become mobilised, thus preventing contamination of the local stream and aquifers.

#### *Contaminated site remediation*

Zeolite is an effective absorber of heavy metals such as lead, cadmium, selenium, mercury, barium, chromium, caesium, copper and many others. For contaminated soils it has application for the absorption and locking up of these heavy metals, thus preventing them from leaching into the environment. ☒

Castle Mountain Zeolites  
PO Box 54, Quirindi 2343

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