White Paper

Reactive Phosphate Rock Fertiliser

The phosphate rock used in agriculture is known by a number of names. Reactive phosphate rock (RPR), direct application phosphate rock (DAPR), mineral phosphate, soft rock, hard rock. Variants on all of these are names or brands used across the fertiliser industry.

What is Reactive Phosphate Rock?

Phosphate rock is a natural mineral. The phosphate component of the mineral is present in the form of apatite – a mineral lattice.

There are two main forms of phosphate rock –

- Sedimentary rock – makes up about 95% of known global phosphate resource and is formed from marine life deposits in ancient seabeds.
- Igneous phosphate rock – makes up the other 5% of known global resource and is formed through volcanic activity.

Phosphate rock formed from guano deposits (such as the rock mined at Nauru) have declined and are small in output.

Can Phosphate Rock be used as a Fertiliser?

Being a mineral, phosphate rocks vary from deposit to deposit. Variations can also occur within a single deposit. Variations may occur in:

- The amount of elements including trace elements, heavy metals, radioactive isotopes, calcium, carbonate, fluorine and silica.
- How well the phosphate is bound within the mineral lattice.

These variations impact the effectiveness of phosphate rocks as fertiliser. Because it is a natural mineral, phosphate rock is often sold and promoted as an organic product.

Even if phosphate rock is ‘organic’ that does not guarantee the effectiveness of phosphate rock as a fertiliser.

Sedimentary phosphate rocks vary in their effectiveness as fertiliser and need to be evaluated on their ability to release nutrient, either by laboratory analysis or in field trials.

Igneous rock phosphate is typically not suitable as fertiliser because the phosphate is tightly bound and is not liberated.

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Determining the Effectiveness of Phosphate Rock as a Fertiliser

To measure the effectiveness of rock phosphate as a fertiliser, industry bodies and governments across the world have tried to define the chemical properties of phosphate rocks (typically RPR) used as fertilisers.

In New Zealand Reactive Phosphate Rock (RPR) is the commonly known and used phosphate rock fertiliser.

To be able to sell phosphate rock as RPR in New Zealand it must meet a number of parameters, including a minimum P content of 10% with a minimum of 30% of the total phosphorus soluble in a defined citric acid test.

There is no standard in Australia that phosphate rock must meet when being used as a fertiliser. However, since 2001 BioAg has been evaluating the phosphate rocks available to us. Our selection of rock is based on a number of criteria but most important is the reactivity of the rock (as measured in a laboratory) and its successful performance in the field, both in Australia and around the world.

New Zealand research concluded that the effectiveness of different RPR's as a fertiliser would be better assessed by using the Formic acid solubility test.[4] Where the higher the result the better the RPR would perform as a fertiliser.

It is now common to use both the Citric and Formic solubility tests to evaluate RPR's.

In the 1990's the CSIRO performed a detailed evaluation of the effectiveness of phosphate rocks as a fertiliser.[1] In their work they compared and classified a number of phosphate rocks.

Table 1 – The table below provides a summary

Rock	Source	Total P (%)	Reactivity*	Solubility in 2% citric acid (1st extraction)	Solubility in 2% formic acid (1st extraction)	Solubility in neutral ammonium citrate (2nd extraction)
Sechura	Peru	12.9	High	40	70	9
North Carolina	USA	12.7	Mod High	36	74	8
Egyptian	Egypt	12.7	Mod	31	49	8
Khouribja	Morocco	14.2	Low Mod	28	56	7
Duchess	Queensland	10.5	Low	30	45	5

Table 1 – The use of citric and formic solubility is common when evaluating phosphate rocks for use as a direct application fertiliser. This table provides a guideline on reactivity, but also a comparison to alternative phosphate rocks.

** Reactivity is based on a subjective grouping based on the solubility results achieved.*

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Phosphorus Availability

Phosphate rock is commonly defined by the total amount of phosphorus or P. However it is the availability of the phosphorus that will determine the product's effectiveness as a fertiliser.

When assessing phosphorus availability the most important aspect is to ensure you use a laboratory that is capable and known for analysing phosphate rocks. Soil and mineral laboratories may not use the correct methods.

Comparing analysis results of different RPR products from the same laboratory is always best.

The common laboratory tests performed to determine phosphorus release are –

- 2 hour extraction in dilute citric acid.
- 2 hour extraction in dilute formic acid.

The results can be provided as %P or as a % of Total P.

In addition there is a plant availability test which will analyse for the amount of phosphorus that will become plant available over a longer period of time.

Table 2 – Below illustrates the variation that can occur between laboratories. All product was from the same cargo.

	Sample 1	Sample 2	
	Lab 1	Lab 2	Lab 3
Total P	12.7%	12.7%	13.9%
Citrate Sol P	4.49%	4.7%	13.8%
Formic Sol P	8.27%	9.1%	13.9%
Citrate Sol P – % of Total P	35%	37%	99%
Formic Sol P – % of Total P	65%	72%	100%
Ca	34.9%	34.5%	37.3%
S	1.06%	1.1%	1.45%
Moisture	1.18%	0.6%	0.45%

Table 2 – Sample 2 was split and sent to two different laboratories. All laboratories are accredited.

While Lab 1 and Lab 2 produced very similar results, the variance in results to Lab 3 (which indicate the phosphate rock is exceedingly reactive) highlights the importance of using the same laboratory to compare different products, but also in ensuring that the laboratory being used has a proven capability and track record in analysing phosphate rocks.

At BioAg we utilise an accredited laboratory with extensive experience in the analysis and methodologies of phosphate rocks.

How can Phosphorus Availability be Improved?

A detailed report on the use of phosphate rocks as fertiliser was produced by the Food and Agriculture Organisation of the United Nations (FAO) in 2004.[2]

The report provides a listing of the options considered available at the time to improve the effectiveness of phosphate release from phosphate rocks. In summary these are:

1. Partial Acidulation
2. Biological means
    a. Phospho–composts (inclusion in organic composts)
    b. Inoculation of seedlings with endomycorrhizae
    c. Use of ectomycorrhizae
    d. Use of phosphate solubilising micro-organisms
    e. Use of plant genotypes
3. Compaction with water soluble fertilisers
4. Mixtures with water soluble fertilisers
5. Phosphate rock elemental sulphur assemblages

BioAg's core phosphate fertiliser product, *BioAgPhos*®, is rock phosphate inoculated and composted with BioAg's proprietary phosphate digesting culture.

The culture contains microbial food sources, enzymes, metabolites and phosphate solubilising micro-organisms.

BioAgPhos is then utilised to manufacture the range of solid fertilisers, *Superb*®, *S10 BioAgPhos*® (containing elemental sulphur), *PasturePrimo*® and *PotPhos*®.

How is Phosphate Content in RPR Measured?

The three common ways to measure phosphate content in phosphate rocks are –

- phosphorus (%P)
- phosphate (%P2O5)
- %BPL (% Boned Phosphate of Lime)

Conversion –

- 1% P = 2.2915% P2O5
- 1% P2O5 = 2.1852% BPL

Example – A product that contains 12.6% P has the same amount of phosphorus as one with 28.9% P2O5.

Reactive Phosphate Rock and BioAg Products

BioAg's products are manufactured using Algerian rock phosphate.

Algerian phosphate rock is a known as a highly reactive rock that is suitable for use as a fertiliser in the right soil and climates. Around 200,000mT per annum of Algerian phosphate rock is used as direct application fertiliser in markets such as Brazil, Europe and Argentina.

The Algerian rock phosphate has been analysed by independent laboratories and contains 12.7%P, of which 35% is extractable in citric acid, 70%is extractable in formic acid and approximately 6% is soluble in neutral ammonium citrate (2nd extraction).[3]

In comparison to the rocks evaluated in the Australian National Reactive Phosphate Rock Project, the Algerian phosphate rock would be considered in the range of moderately high to high reactivity.

As a comparison, Duchess Rock (where tailings from the beneficiation process are sold in the market as Soft Rock or Colloidal Rock), has around 10.5% P and was rated as being of low reactivity.

This shows that Algerian phosphate rock has greater value on two fronts, being higher in P content and having higher reactivity.

By utilising a higher grade reactive phosphate rock, BioAg is able to produce a high value phosphate fertiliser – *BioAgPhos*.

BioAgPhos has been used in a number of replicated trials to validate its value as a fertiliser.

The results of these trials, testimonials and case studies are available on the BioAg website at bioag.com.au

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More about BioAg Fertilisers

BioAg is a leading supplier of natural and sustained release fertilisers in Australia, containing well below maximum allowable limits of contaminants.

As a major importer of high-grade reactive rock phosphate, we are able to deliver a secure source of phosphate based fertilisers year round.

Our products can be used at lower volumes, saving transport and storage costs. We deliver fertiliser products and programs that are tailored to the needs of customer's individual paddocks and enterprises.

Our programs deliver results through the smart selection of a complementary suite of high grade agricultural products.

For example, a proven source of continuous and long lasting phosphorus such as *BioAgPhos* is perfectly complemented by a high grade and ideal starter (pop up) fertiliser like DAP.

BioAg Liquids

At planting, *Soil & Seed*® conditions the soil and prepares it for maximising moisture and nutrient retention, and fertiliser use efficiency.

Tailored towards increasing vegetative growth, the foliar *Balance & Grow*® provides a very wide range of food sources that act very fast after application is complemented by other inputs such as calcium nitrate or gibberellic acid.

Fruit & Balance® is the final stage in foliar applications, providing very available and fast acting food sources tailored for flowering and fruit set.

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1 McLaughlin M.J. , Fleming N. K. , Simpson P. G. , Bolland M. D. A. , Gilkes R. J. , Sale P. W. G. , Blair G. J. , Hepworth G. , Gilbert M. A. , Stewart J. , Garden D. L. , Dann P. R. , Hamilton L. , Hunter J. , Cayley J. W. D. , Ward G. N. , Johnson D. Lewis D. C. (1997) National Reactive Phosphate Rock Project — aims, experimental approach and site characteristics. Australian Journal of Experimental Agriculture 37, 88504.https://doi.org/10.1071/EA96105.

2 Food and Agriculture Organization of the United Nations (FAO) 2004 Use of phosphate rocks for sustainable agriculture.

3 Direct application phosphate rock: a contemporary snapshot. Phos. Pot., 200: 27–37.

4 Comparison of six phosphate rocks and single superphosphate as phosphate fertilisers for clover-based pasture; A. G. Sinclair etal; 2010

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Better soils. Better crops. Better stock.