

guargum-coated urea has been tested in cultivars of cauliflower in comparison with urea super granule, lac-coated urea and neem-extract-coated urea. The highest yield is obtained with our urea and neem-extract-coated urea. In cauliflower and brinjal cultivars, net return is obtained using our urea. In comparison with other slow-release areas, the preparation technique (simple mixing in a tumbling mill) adopted in our case is simpler and cheaper.

The above-described results indicate that drag-reducing polymers not only reduce the energy required by sprinkler irrigation systems by reducing the turbulent drag but also reduce the percolation losses of soils and thus may be used as blending agents for the development of slow-release urea. Though the application of drag-reducing polymers in agriculture to serve any individual purpose may be expensive, the cumulative benefits of polymer additives in sprinkler irrigation, decrease in hydraulic conductivity, slow-release preparation, etc., may prove this technology economically feasible²⁶. A large number of efficient shear- and biodegradation-resistant grafted polysaccharide-based drag-reducing agents have been developed in the first author's laboratory^{10, 27} at Materials Science Centre. Efforts are in progress to choose among them a drag-reducing polymer which will give optimum reduction in the energy requirement of sprinkler irrigation as well as in percolation losses.

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Neodymium monazite from the Gajularega cordierite gneisses, Eastern Ghats, India

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Neodymium monazite, occurring as an accessory phase in cordierite gneisses at Gajularega in the Eastern Ghats, is reported for the first time from India. Optically, it is characterized by bright honey yellow to rose colour, low optic axis angle, biaxial positive interference figure and pleochroic haloes with weak pleochroism. X-ray diffraction data with d values at 3.280, 3.081, 2.846, 2.425 Å reflect monazite-Nd mineral structure. Monazite-Nd invariably shows LREE (light rare earth elements) selectivity. The PO_4^{3-} impoverishment in analysis suggests higher $f\text{CO}_2$ conditions. It is considered as uniphase multicomponent solid solutions containing U, Th, Zr and Y, with Nd-rich LREE dominance with coupled substitutions. Metamorphic origin is assigned to Nd-rich monazite from the Eastern Ghats. Nd-rich REE derived from the pegmatitic intrusions in khondalites and entered into cordierite gneisses during metamorphism.

NEODYMIUM monazite (monazite-Nd)¹ has been found as an accessory mineral from a lensoidal outcrop of cordierite gneisses from the Eastern Ghats at Gajularega village (lat. 18°8'10"N and long. 83°23'20"E) in Viz-

ianagaram District, Andhra Pradesh. It is being reported for the first time. Greaser and Schwander¹ have reported monazite-Nd from Pta. Glogstafel, Val Formazza, Italy. Cordierite gneisses occur as small lensoidal patches in the garnet sillimanite gneisses (khondalites) with quartzites and pegmatitic veins exhibiting E-W and ENE-WSW trends. Cordierite occurs both as stumpy tabular and as xenoblastic grains characterized by numerous dusty inclusions, with pleochroic haloes around monazite-Nd and incomplete lamellar or sector twinning. Different mineral assemblages associated with cordierite gneisses are: (1) spinel + cordierite + magnetite + monazite; (2) cordierite + monazite + ilmenite-magnetite ± sapphirine; (3) monazite + spinel ± plagioclase ± quartz; (4) monazite + plagioclase + garnet ± spinel.

Table 1. Chemical analysis, structural formulae of monazite-Nd

Wt %	Structural formula on the basis of 16(O)
La ₂ O ₃ = 4.65	La = 0.29
Ce ₂ O ₃ = 16.92	Ce = 1.07
Pr ₂ O ₃ = 2.43	Pr = 0.15
Nd ₂ O ₃ = 28.49	Nd = 1.75
Sm ₂ O ₃ = 4.92	Sm = 0.29
Eu ₂ O ₃ = 1.04	Eu = 0.05
Gd ₂ O ₃ = 3.94	Gd = 0.23
Dy ₂ O ₃ = 0.52	Dy = 0.03
Er ₂ O ₃ = 0.24	Er = 0.01
Yb ₂ O ₃ = 0.86	Yb = 0.04
Lu ₂ O ₃ = 0.84	Lu = 0.04
Y ₂ O ₃ = 1.95	Y = 0.18
ZrO ₂ = 0.96	Zr = 0.08
ThO ₂ = 6.82	Th = 0.27
UO ₂ = 0.64	U = 0.02
CaO = 0.16	Ca = 0.03
P ₂ O ₅ = 24.62	P = 3.59
100.00	8.12
	ΣREE = 3.95
	Σ(Y, Zr, Th, U) = 0.55
	Σ(Ca, P) = 3.62

Table 2. X-ray diffraction data

d (Å)	I ₀ / I ₁	h k l	Crystallographic constants
4.150	30	$\bar{1}11$	System - monoclinic
3.280	60	200	a ₀ = 6.745
3.081	100	120	b ₀ = 6.691
2.8847	90	$11\bar{2}$	c ₀ = 6.430
2.846	60	$\bar{1}12$	Z = 4
2.425	40	$\bar{2}12$	D _x = 5.41 (calculated)
2.4259	48	$\bar{2}12$	D = 5.42 (measured)
2.3395	6	022	Optically positive
2.1814	25	031	β = 103°42'
1.954	30	212	ηγ = 1.86
1.8775	15	103	2ν = 12°
1.7902	13	023	
1.6924	20	321	

Optically pure monazite-Nd fractions were separated using the Frantz isodynamic separator and treating the fractions with heavy liquids. Separated mineral fractions were used for X-ray diffraction studies and chemical analysis. REE, U, Th and other elements were analysed using inductively coupled plasma mass spectrometer (ICPMS). A complete chemical analysis and the calculated structural formulae of monazite-Nd are given in Table 1, and X-ray data along with the calculated crystallographic constants are given in Table 2.

Monazite-Nd occurs as fine grains (3-10 μm) in prismatic crystal form, exhibiting bright honey yellow to rose colour. Using the pycnometer, the specific gravity of the mineral grains was determined to be 5.42 g/cm³. It crystallizes in monoclinic form, with low optic axis angle (2ν) of 12° and with weak dispersion, r < v. It exhibits pleochroic haloes with weak pleochroism. Biaxial positive interference figure is a characteristic of this mineral. Refractive indices of the mineral are α = 1.789, β = 1.793 and γ = 1.871. The structural formula of monazite-Nd calculated on the basis of 16(O) is [(REE)_{23.95} (U, Th, Zr, Y)_{2.055} (Ca, P)_{3.62} O₄].

The theoretical REO (rare earth oxide) content for monazite² with Ce:La ≈ 1:1 is 69.73 wt%, but in this mineral (monazite-Nd), U, Th, Y and Zr substitute for REE, that lower the REO content with Σ(La + Ce + Pr) = 24 wt%. Nd/Σ (La + Ce + Pr) is 1.16 as against 0.28 for reported normal monazites³.

Unit cell parameters of monazite-Nd are: a₀ = 6.745, b₀ = 6.691 and c₀ = 6.430 Å, which are lower than the values for normal monazites. Lower cell dimensions suggest that REE substituting for U⁴⁺ and Th⁴⁺ are essentially LREE, which have slightly larger ionic radii (1.079-1.16 Å) than that of U⁴⁺ (1.00 Å) and Th⁴⁺ (1.05 Å). X-ray diffraction (XRD) data with d values at 3.280, 3.081, 2.846, 2.425 Å suggest monazite-Nd mineral structure. d spacing at 2.8847 Å may be due to some impurity associated with monazite grains subjected to XRD analysis.

The impoverishment of phosphate (PO₄³⁻) in the analysis of mineral suggests higher fCO₂ conditions, where early stages of crystallization might have preferred strong precipitation with Nd-rich LREE in coordination 9 along with cordierite formation. Monazite-Nd along with cordierite is a product of recrystallization and authigenic growth in response to retrograde metamorphic conditions during the third phase of tectonogenesis with high Nd, Th contents with variable U. The REE derived from pegmatites, which are close associates of garnet sillimanite gneisses and quartzites, and entered into cordierite gneisses during metamorphism. Cordierite enclaves around monazite-Nd grains suggest that crystallization of monazite-Nd completed prior to cordierite crystallization and these coeval tendencies expressed in textural evidences.

Monazite-Nd is considered as a uniphase multicomponent solid solution containing U, Th, Y and Zr, with Nd-rich LREE dominance with coupled substitutions of U and Th for Ce. Metamorphic origin was assigned to neodymium-rich monazite from the Eastern Ghats. Detailed geochemical and mineralogical studies of these rocks are underway.

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Global methane emission from rice paddies: Excellent methodology but poor extrapolation

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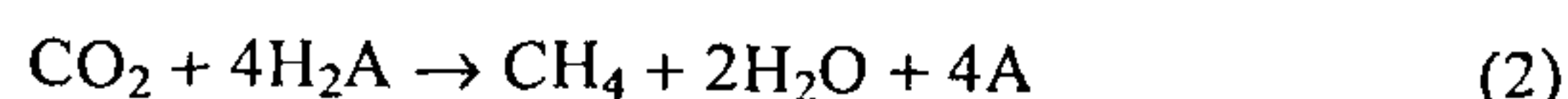
Methane emission from rice paddies would require a source of carbon as a substrate and a reducing soil environment. The maximum methane production from glucose, presuming it as a source of carbon, was estimated on the basis of known micro-biochemical reactions. The total biomass of rice paddies from the various regions was estimated using grain yield and biomass partition coefficient (Harvest Index). The relation of biomass and methane emission was used as reported earlier for estimating methane emission from rice paddies. The maximum global methane emission from rice paddies was estimated 7.08×10^{12} g as against 110×10^{12} g and 60×10^{12} g reported by IPCC in 1990 and 1994, respectively. The need for identifying new sources of methane is emphasized, and the limitations of experimental methodology highlighted.

METHANE has been identified as an important greenhouse gas which can contribute to global warming. It has been estimated that methane accounted for 15% towards the global warming effect from 1800 to 1990. Therefore, efforts have been made to identify sources and sinks of methane to account for its annual increase in the atmosphere.

The estimates of methane release from rice paddies are based essentially on the studies conducted at Davis Campus, University of California, USA, and Vercelli in Italy. These authors have developed excellent techniques of sample collection and measurements but their biological and agricultural aspects have not been well attended to. The extrapolations lack realism, leading to excessive overestimation of methane release from rice paddies. This has possibly diverted attention from the as-yet unidentified source of methane. This commentary examines the limitations in estimates of methane release from rice paddies. However, before a new basis of estimates is presented, the mechanism of methane release from rice paddies is described, followed by a section on extrapolation.

Mechanism of methane release from rice paddies

1. The rice plant does not produce any methane by itself. It only serves as a mechanism of transport of methane dissolved in rhizosphere¹.
2. Methane is produced in a reduced environment by one of the three groups of methanogenic bacteria. The mechanism involves conversion of various organic acids such as acetic acid produced from organic carbon to methane as follows:



Therefore, the occurrence of organic carbon is an essential requirement for generating methane.

3. Besides organic carbon in the soil, the rice plant could leach some amount of the organic carbon in the rhizosphere and in the soil. The more the organic carbon content of the soil, the higher will be the potential for methane production.
4. The methanogenic bacteria are active in the pH range of 6.5-8.0. In acidic environment they do not function. In addition, the saline water and hence saline soil impairs methane formation remarkably².

Several authors have made the following observations which they found difficult to explain^{3-5, 9, 10}.

- I. The rice plots heavily fertilized (200 kg N ha^{-1}) had more methane emission than non-fertilized plots.
- II. There was a diurnal variation in methane emission which increased in the late afternoon reaching a peak between 1800 and 2100 hours but becoming very small by early morning. This observation has to be noted for California, USA, Italy or Germany, where the crop is grown in summer, when the day length is 16 h or more, providing a prolonged photosynthesis duration.