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Content

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HISTORICAL NOVEL & KHUSHWANT SINGH

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ABSTRACT
History is a record of various events that transpired in different times. Most of the histories of Partition written either as accounts of victory or as nightmares are constructed in the form of compelling narratives concerned with the metaphysical identities of different communities and their collective fate. They are teleological histories in which the past is given a retrospective intelligibility and rationality. The fact of the partition permits them to arrange a diverse variety of discrete incidents into a successive and logical order so that they inevitably lead to a known and expected end. Khushwant Singh's style is terse at times, his range of choice of words is unfathomable, and his observations of the Indian Scenario bring the reader very close to the soil where he inhales the essential countryside fragrance enveloped with the urban mannerism. Khushwant Singh's agenda seems to be at all, to take a balanced view of history and society. His history is not that of a historian discovering history but that of an artist living history. He stands apart for his presentation of what is already known. This research paper presents the author's view that he use a different point of view and a novel technique in portraying history.

INTRODUCTION

Khushwant Singh has written many books on history religion and many other topics. His literary fame rest with Train to Pakistan. He uses history in his all three novels, Train to Pakistan, I shall not hear the Nightingale and Delhi. Khushwant Singh's heroes are doomed heroes. I shall not hear the nightingale has a limited range and covers the freedom movement. The novel presents both the violent and non violent struggle for freedom during this period. Delhi is a witness to the large panorama of history – both the brave and the bawdy. He balances both the ugly and beautiful elements of humanity. The novel is informed of the current political and ideological climate and is wary about the future.

Style and Observation

Khushwant Singh frame the narrative within the bounds of a journey that takes place at the end. The journey's motif is of course implicit. The movement in the novel occurs essentially on two planes the micro and the macro. The former plane would include the presentation and praxis of individual history and the latter, the enactment of large impersonal historical forces. This generates the narrative tension between 'history' (historical events like the partition) and his history (Individual / personal histories). This distinction does not refer to a feature that feminism and post colonialism share, notably a distrust of the critiques of official historical narratives.

This tension between history and his story where one tries to merge with the other albeit unsuccessfully is highlighted by the detailed use of everyday objects that impinges on the reader's consciousness. Indeed one can hardly fail to notice the loving care Singh lavishes on the sheer physicality of objects presenting them in sharp focus even in the midst to dialogue so much so that sharp edges, the sense of weight or the glint of metal make their corporeality felt. In Train to Pakistan the shock treatment is deliberate and

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effective. The tension in the narrative between the private worlds of Mano Majra, the lives of its poor inhabitants and the larger world of the bureaucracy and the state, between his-story and history is thus achieved through a sharp focus on objects familiar and of everyday.

Khushwant Singh's style is terse at times, his range of choice of words is unfathomable, and his observations of the Indian scenario bring the reader very close to the soil where he inhales the essential countryside fragrance enveloped with the urban mannerism.

Writing Technique

Khushwant Singh has not lost his zest and fervor for life. He is a great writer of Indian English. He is indeed among the very few who, unmoved by the linguistic claptrap, has introduced the richness & bewildering variety of Urdu to English-speaking readers. In the writing of creative works, Khushwant Singh finds any Indian language a poor substitute for English. English we argues is a hybrid language, enriched by every language it came into contact with, including some ten thousand words from Indian languages. He advocates a free adoption of this language for our own purposes.

He said, what is the harm in taking English over and mauling it as we wish and pronouncing it as we want. This not merely suits the Indian conditions but will be quite worth while doing it in terms of the international importance of the language. These are bound to become controversial, given the Indian situation and the chauvinists of the regional literatures. Such bold assertions, notwithstanding the onslaught of the detractors, can be made only by a Khushwant Singh. Khushwant Singh's contribution to India's multicultural ethos is so significant. He is tolerant, eclectic and intellectually committed to pluralism and multiculturalism. His approach towards life in all matters is essentially liberal.

Historical Novels

Khushwant Singh first novel Train to Pakistan frame the narrative within the bounds of a journey that takes place at the end. As the larger historical forces touch Mano Majra, the state machinery literally swings to action. Singh is careful to emphasize the physicality of the rough large mud green army trucks laden with soldiers armed with sten guns carting away the wood and oil provided by the villagers on demand for some unknown reason.

With order for evacuation of Muslims from the village, as Imam Baksh a much-respected weaver of the village goes to pack, Singh is careful to provide an inventory. Their familiarity and spartan quality highlight the misery and poverty of the Punjabi peasant and by implication the majority of those million who were uprooted by the partition. His second novel I shall not hear the Nightingale also important for historicity. It is a minor novel. The time of the novel is after Independence of India and Khushwant Singh discusses the history of loyalty of Buta Singh and son Sher Singh for British Empire. And his third novel Delhi is full of historical events.

All the episodes of history are narrated in first person by the protagonist to give the narration the intensity of authenticity, Each episode of history is Co-related with the Bhagmati episode so as to provide an easy access to past and present. The novel begins with a very typical Khushwant Singh's style. But the ruins of certain historical places unfold a new vista. Thus starts the journey of the reader through time, space and history. The reader is shifted to the past as Mussaddilal narrates his time. The history is brought to a state of stand still, as the scene shifts from generation to generation, emperor to emperors and from Lalkot, Mehrauli, Shahr-I-Nam, Tughlakabad to Delhi, present to past and then to present again. The interest is sustained and the comparison between the times past and the times present continues.

Conclusion

Khushwant Singh all historical novel defies the usual modes of literary classification. Khushwant Singh has written many books on history, religion and Sikhs. His literary fame rests with Train to Pakistan which was one of the first novels on Partition written in English A.G. Khan considers it a brilliant, brutally realistic story.

Kamal Mehta studies the impact of Partition on different characters in the novel and opines that Singh chooses to narrate the disturbing impact that the community deeply felt at the social and psychological level. Darshana Trivedi studies the

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character of Sabhrai in I shall not Hear the Nightingale and opines that Sabhrai is an epitome of Indian womanhood. J.D. Soni observes that time has changed the rulers have changed but Delhi remains the same, the tremors of the past may yet get repeated. Delhi is a witness to the large panorama of history.

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Phenolic effect on haematological alternations of a freshwater catfish Channa punctatus

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ABSTRACT
The present research work will be a pre-impoundment type of research regarding the possible threats and damage caused by the phenol and phenolic compounds particularly the aquatic ecosystem and will help us to enlist the phenol under the highly toxic pollutant particularly to fish even under sublethal doses. The effect of phenol on haematological alternations of Indian catfish, Channa punctatus was observed. After exposure to sublethal concentrations of 6.99 mg l-1, the number of red blood cells, haemoglobin content and packed cell volume all decreased but the glucose level increased.

INTRODUCTION

The phenolic pollution represents a threat against natural environment and also to human health. When phenol is present in the aquatic environment, fish food consumption, mean weight and fertility are significantly reduced. Exposure of fish to different types of pollutants (industrial effluents, pesticides and heavy metals) Phenolic wastes are common water pollutants generated from a variety of industrial processes used in oil refineries, gas operation, coke ovens, coal gasification and by natural processes such as the decomposition of plant matter (Buikema et al., 1979). Relatively high concentrations of phenol are found in rivers near the outlets of channels where industrial wastewaters have been discharged (Buikema et al., 1979; Loh et al., 2000). Blood is the most important and abundant body fluid. Its composition often reflects the total physiological condition. The main route of entry for any pesticide is through the gills. From the gills, it is transported to various parts of the body via the blood stream.Blood provides an ideal medium for toxicity studies. The haematological parameters have been considered as diagnostic indices of pathological conditions in animals. Fish blood can serve as a valuable tool in detecting physiological changes taking place in animal. Hence, an attempt has been made to study the effect of phenol on certain blood components of Indian catfish.

Materials and Methods:-

Catfish namely channa punctatus (15-20 g) were acclimated to laboratory conditions for 15 days. Such acclimated fishes were exposed to sublethal concentrations of phenol for 12 days (6.99 mg l-1). After the period of exposure, the haemotalogical parameters were determined. The total RBC count was made by using Neubauer crystalline counting chamber as described by Davidson and Henry (1969). The haemoglobin was estimated by acid haematin method (Sahli, 1962). The packed cell volume (PCV) was estimated by using Wintrobe's tube (Mukherjee, 1988). Blood glucose was determined using Folin Malmros microprocedure as modified by Murrell and Nace (1958).

Results and Discussion:

In the present study, a decrease in total erythrocyte count, Hb concentration, PCV and an increase in blood sugar concentration was observed in the exposed fishes .

Halsband and Halsband (1963), measured a 12% increase in haematocrit values for rainbow trout exposed to 1.5 mg l-1 phenol for 48 hr, this increase

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may have been caused by factors other than the direct result of the phenol since the erythrocyte numbers were shown to have decreased by 25% although a 26% increase in the mean cell surface area was reported. However, neither Kristofferson et al. (1973) using pike, Esox lucius L., exposed to 5 mg l-1 phenol for 5 days nor Swift (1978) using rainbow trout exposed to phenol for 24 hr, could detect any significant changes in PCV values.

Swift (1978) reported significant concentrations of phenol in the whole blood plasma and erythrocytes of Salmo gairdneri, exposed to phenol for 24 hr. Damage to blood cells is a recognised symptom of acute phenol poisoning in mammals and such similar results were obtained for fish exposed to near lethal levels of phenol by Waluga (1966b). The number of mature erythrocytes decreased while the number of disrupted and immature erythrocytes and white cells increased.

Significantly increased PCV and whole blood glucose values were observed by Swift (1981), when the fish were exposed to 4.2, 6.9 and 7.8 mg l-1 phenol. However, this significant increase appeared to be limited to the first few hours of exposure, although 24 hr exposure to 6.9 mg l-1 led to a significant decrease in glucose concentration. The other phenol concentrations tested had no significant effect on whole blood glucose values. Similarily increase in the PCV value have been reported for a number of fish species exposed to various experimental conditions (Houstonet al., 1971; Soivio and Oikari, 1976; Casillas and Smith, 1977). Chatterjee et al. (1983) reported histopathological lesions in the blood of Heteropneustes fossils at 5-10 ppm of phenol.

Although changes in blood haematocrit and water balance did not appear but Kristofferson et al. (1973) stated that the plasma activities of the enzymes, lactate-dehydrogenase (LDH), glutamate-oxalo-acetate-transaminase (GOT) and glutamic-pyruvic transaminase (GPT) were significantly increased in pike fish exposed to phenol. Background information on 'normal' plasma enzyme levels are unavailable, however, the ratio of GOT to GPT and LDH to GOT for treated fish compared to control fish indicates damage to the erythrocytes (Schmidt and Schmidt, 1967). Extension of this type of approach would provide useful data as suggested by Bell (1968). In Mugil auratus after an 8 day exposure to 7.5 mg l-1 phenol, blood haemoglobin concentration, haematocrit value were below controls and blood sugar concentration and the activities of aspartate aminotransferase and glutamic-pyruvic transaminase were above controls (Krajnovic-Ozretic and Ozretic, 1988). The effects of phenol on haematological properties of catfish (Clarias leather) were reported by Chen (2002). After exposure to 5 to 30 mg l-1 phenol for 24 hr a decrease in the number of red blood cells and haemoglobin content and an increase in the erythrocyte sedimentation rate were observed. The changes in haemoglobin concentration, haematocrit and blood glucose in the present study are similar to those reported by Krajnovic-Ozretic and Ozretic (1988) for phenol. The decrease in RBC and Hb content in the present study are also comparable to those reported by Chen (2002) for catfish Clarias leather exposed to phenol. The decrease in RBC and Hb concentration indicates acute anaemia. The anaemia could be due to the destruction of RBC (Waluga, 1966a, b; Andres and Kurazhovskaia, 1969) triggered by the influx of phenol into the erythrocytes (Swift, 1978). The anaemia may also be of haemolytic type. Haemolysis of RBC was also reported by Krajnovic-Ozretic and Ozretic (1988) in gray mullet exposed to phenol. Haemolysis of erythrocytes were also observed after exposing the erythrocytes, experimentally in vitro, to 2 mM dichromate for 24 hr (Roche and Boget, 1993). In the present investigation, haemolysis might have been one of the causes for reduction in Hb, RBC and PCV values. The fall in haematological parameters might be due to decreased rate of production and/or to an increased loss of destruction of RBC (Larsson, 1975). The another reason for RBC suppression could also be damage to the haemopoeitic tissue. PCV appears to be positively correlated with RBC counts, hence, a decrease in PCV is observed.

Similar results have been reported for several freshwater fishes exposed to pesticides (Khalaf Allah, 1999; Rehulka, 2000). An elevation of blood sugar (hyperglycaemia) is observed in all the exposed fishes. This could be attributable to the physiological stress caused by phenol. Similar increase in whole blood glucose concentrations were reported in fish exposed to 3.2, 7.3 and 8.5 mg l–1 phenol (Swift,

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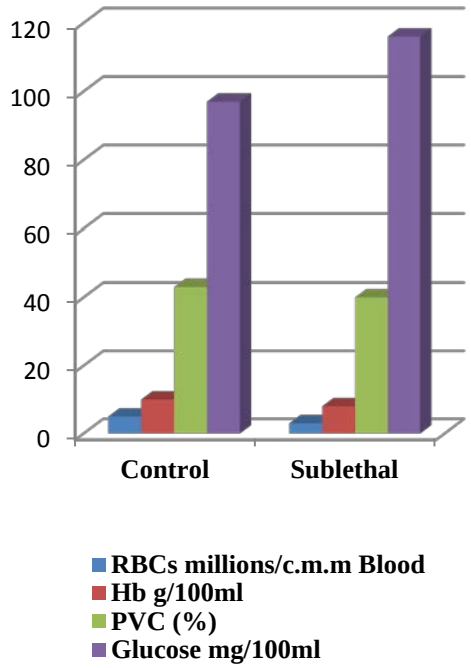
1981). Ravichandran et al. (1995), reported similar hyperglycaemia in the freshwater fish Oreochromis mossambicus exposed to sublethal concentrations of phenol. Blood glucose has been shown to be a sensitive biochemical indicator of environmental stress for any chemical pollutant including pesticides (Silbergeld, 1974; Wedemeyer and Yasutake, 1977). The blood sugar level represents a dynamic balance between the rate at which the sugar is entering the blood. When fish absorb little oxygen from the environment, the respiratory metabolism is depressed and therefore stored intracellular glycogen is utilized. Under such conditions, the hyperglycemic hormone is released for the degradation of glucose. This glucose leaks into the blood causing hyperglycaemia (Bhattacharya et al., 1987).



The decrease in total erythrocyte count, Hb concentration, PCV and an increase in blood sugar concentration was observed as Glucose > PVC > Hb > RBC.

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APPLICATIONS OF ZEOLITE STILBITE TO REMOVE HEAVY METAL CADMIUM (II) AND AMMONIA FROM ENVIRONMENT

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ABSTRACT
In this study the properties of partially Cd(II) exchanged Zeolite Stilbite and its ammonia adsorbed derivative have been investigated by IR spectroscopic, thermogravimetric, atomic absorption and X-ray diffraction methods. Analytical data reported showed the extent of exchange. Thermal stability and structural changes of the derivates have been discussed. thermogravimetric data have been used to calculate kinetics of various thermal events. Cell parameters have been evaluated from XRD data. . From the experiments, it can be concluded that Zeolite Stilbite can be used to remove heavy metal Cadmium and partially Cd(II) exchanged Zeolite Stilbite can successfully remove hazardous gas ammonia and ammonium ions.

INTRODUCTION

Cadmium waste streams from the industries mainly end up in soils. The causes of these waste streams are for instance zinc production, phosphate ore implication and bio industrial manure. An exposure to significantly higher cadmium levels occurs when people smoke. Tobacco smoke transports cadmium into the lungs and severely damages the lungs. Cadmium strongly adsorbs to organic matter in soils. When cadmium is present in soils it can be extremely dangerous, as the uptake through food will increase. This is a potential danger to the animals that are dependent upon the plants for survival. Earthworms and other essential soil organisms are extremely susceptive to cadmium poisoning. They can die at very low concentrations and this has consequences for the soil structure. When cadmium concentrations in soils are high they can influence soil processes of microorganisms and threat the whole soil ecosystem. Exposure to high concentrations of ammonia in air causes immediate burning of the eyes, nose, throat and respiratory tract and can result in blindness, lung damage or death. Inhalation of lower concentrations can cause coughing, and nose and throat irritation. Ammonia may also cause burning in the trachea and nasopharynx. In aquaculture ammonia is very toxic for fish and small concentrations of it will already lead to diseases and inhibition of growth. In higher concentration ammonia can be lethal to fish. In swimming pools, ammonium ions are brought in the water by swimmers. It often reacts with the free chlorine to form chloramines. They are irritating to the eyes and skin. Various treatment processes are available to solve the above problems among which the use of natural zeolite as an ion exchanger and adsorbent of gases gained importance due to their availability and low cost. Therefore number of research has been conducted by different persons in this field[1-5]. Zeolites are crystalline hydrated alumino-silicates, which are known to have an affinity for heavy metals, ammonium($NH4^+$) and other cations. Zeolite is a naturally occurring hydrated aluminosilicate mineral. It is an inorganic porous material composed of three dimensional frameworks of SiO_4 and AlO_4 tetrahedra, exchangeable large cations (sodium, potassium and calcium) and loosely held water molecules permitting reversible dehydration. It is in many ways the inorganic equivalent of organic enzyme. Stilbite is a natural zeolite. Chemical formula of Stilbite is

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$NaCa_4Al_8Si_{28}O_{72}.28H_2O$. The present work involves the use of zeolite Stilbite for preparing its cation-exchanged derivative with Cd(II) ions and using it for the adsorption of ammonia. Characterizations of such derivatives have been done to make them useful to control environmental pollution.

Material and Methods

The Stilbite specimen, from the region around Decan trap, was obtained from GST, Pune. It was finely powered in a mechanical grinder and sieved to obtain uniform particle size. In order to remove the soluble impurities, sample were washed at 70^0C for 6 hours with continuous stirring. Then the sample were drained and dried at 110^0C overnight. The partially Cd(II) exchanged derivative of Stilbite was prepared by treating 10g of the finely powered form of Stilbite with 500 ml of 0.1 M aqueous solution of cadmium nitrate at temperature 25^0C in a 500 ml plastic bottle. The bottle was shaken for 20 hours. Filtering, washing and air drying resulted in the formation of a exchanged derivative of Cd(II) Stilbite. The adsorbed derivative of this exchanged form with Ammonia was prepared by the procedure described in an earlier communication[6]. The Cd(II) exchanged Stilbite was analyzed for Sodium(1), Calcium(II) and aluminium(III) using Varian Techtron AA-6 atomic absorption spectrometer. TG analysis of exchanged and adsorbed samples was carried out in air at a heating rate of 10°C per minute up to 800°C on a thermo balance supplied by FCI Sindri. IR spectra of the samples and their residues after heating up to 500°C in a muffle furnace was recorded in KBr phase between 4000 Cm^{-1} and 200 Cm^{-1} on a Perkin Elmer IR spectrophotometer. X-ray diffractograms were obtained between 2 Θ angles of 5° and 70° using a Philips PW 1140 X-ray unit and copper Kα radiation.

Results and discussion

Analytical data obtained for Stilbite and Cd(II) exchanged Stilbite are shown in table 1. Compared to analytical data obtained for Stilbite[7] the Cd(II) exchange brings about almost complete exchange of sodium(I). It has been shown by earlier workers that Cd(II) ions exchange reversibly for most of the sodium(I) in A type zeolites[8]. During ion exchange reaction 63.79% of Ca(II) and 99.33% of Na(I) are replaced by Cd(II) ions. The Na/Al and Ca/Al ratio in the original Stilbite are lowered from 0.076 to 0.0019 and 0.58 to 0.24 respectively as a result of cation exchange.

IR Spectral Analysis

IR spectra of Cd(II) exchanged Stilbite and its ammonia adsorbed derivative and also their residues after heating up to 1073K are reported in the region between wave number 4000-200 cm^{-1}. Summary of IR spectral data is shown in table 2. IR Spectra of Cd(II) exchanged Stilbite shows typical hydrated structure but the intensities of the IR spectral bands of Stilbite are reduced to a considerable extent as a result of exchange with Cd(II) ions. Both physical and chemical adsorption of ammonia occur on Cd(II) exchanged Stilbite. The doublet at 1450 and 1420 cm^{-1} characterizes bending modes of ammonium ions. The appearance of two bands is consistent with C_{3v} symmetry indicating that tridentate species are predominant in the zeolite. Band at 3620 cm^{-1} in Cd(II) exchanged Stilbite is shifted to 3450 cm^{-1} and become more intense in ammonia adsorbed derivative. This is due to N-H stretching besides O-H stretching. Evacuation of the sample up to 1073 K leads to destruction of all NH_4^+ species and appearance. It is also clear from the IR spectra of residue of both samples that structure of Zeolite is partially contracted and destroyed at high temperature. Both contractions and destructions are due to attractive force of extra framework cations[9]

Thermogravimetric Analysis

Cd(II) exchanged Stilbite shows a weight loss of only 17.35% on TG analysis. It is clear from TG data of Cd(II) exchange Stilbite that major step of weight loss occurs between 393k to 593k. Further weight loss beyond 593k takes place at a much slower rate. The ammonia adsorbed derivative of Cd(II) exchange Stilbite shows a weight loss of 24.85% on TG analysis. It loses weight in three steps. After dehydration and desorption proceeding up to 533k continuous destruction of all NH_4^+ species takes place.TGA is

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used to calculate kinetics of various thermal events by the method described in earlier communication[10]. Thermal data and kinetics parameters of different steps are shown in table 3.

X-ray Diffraction Analysis

Crystal structure of Stilbite is monoclinic c/2m with a=13.63, b=18.25, c=11.31 and β=128.4^0 There is no major difference between X-ray diffractograms of Stilbite and Cd(II) exchange Stilbite. Adsorption of ammonia on Cd(II) exchange Stilbite produces an intense reflection (222) on 4.57A^0, reduces intensity of reflection (001) on 8.85A^0 and some reflections become indistinct.

Conclusion

Chemical analysis of Cd(II) exchanged form of zeolite Stilbite shows considerable extent of exchange therefore zeolite Stilbite can be used as the filter in cigarette and other industries where compounds of cadmium formed as byproduct. The exchanged form is capable of adsorbing undesirable gaseous adsorbate like ammonia by both physical and chemical adsorption therefore it can be used in aquaculture industry to decrease ammonia concentrations and toxicity.

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Table 1 Analytical data

	Na %	Ca%	Al%
Stilbite	0.62	4.76	8.15
Cd(II) exchanged Stilbite	0.014	1.72	7.02

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Table 2 Summary of IR spectral data

Sample	IR Peak (Wave number cm^{-1})	Assignment
Cd (II) exchanged Stilbite	3620SB	O-H stretching
	1660S	O-H bending
	1040SB	Asymmetric T-O stretching
	565SHM	Double rings
	445S	T-O bending
	330SH	Pore opening
Cd (II) exchanged Stilbite + Ammonia	3450SB	O-H stretching,N-H stretching
	1650 S	O-H bending
	1450,1420	Bending mode of NH_4(I)
	1025WB	Asymmetric T-O stretching
	715SH	Symmetric T-O stretching
	565SH	Double rings
	440S	T-O bending
	360SH	Pore openings
Residue of Cd (II) exchanged Stilbite	3570W	O-H Stretching
	1035 SH	Asymmetric stretching
	770W	Symmetric T-O Stretching
	460W	T-O bending
Residue of Cd (II) exchanged Stilbite + Ammonia	3420W	O-H Stretching
	1070W	Symmetric T-O Stretching
	760SH	Symmetric T-O Stretching
	455W	T-O bending

S-Strong

B-Broad

M-Medium

W-Weak

SH-Shoulder

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Table 3 Thermal data and kinetics parameters

Sample	Total weight loss %	Weight loss steps% with temperature	Rate of reaction from g(α)Vs time value for n=2. ($x10^{-2}$ min^{-1})	Activation energy from $log_e g(\alpha)/T^2$ Vs $10^3/T$ value for n=2. ($KJ\ Mole^{-1}$)
Cd (II) exchanged Stilbite	17.35	2.25 up to 393k 13.40 up to 593k 1.70 after 593 k	12.80 5.50 0.72	14.95 22.50 36.72
Cd (II) exchanged Stilbite + Ammonia	24.85	20.30 up to 553k 3.25 up to 633 k 1.30 after 633 k	8.80 0.33 0.51	19.91 44.19 31.83

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A STUDY ON HEALING OF OZONE AND SOME OF ITS PROVING FACTS

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ABSTRACT
Since a long time, there is always a talk about ozone protection that the ozone hole is increasing day by day. And one day it can create havoc. According to a new research, scientists observe first sign of healing in Antarctic ozone layer which was the biggest trouble. In 1974, in Nature, Mario Molina and Sherwood Rowland, two chemists at the University of California, Irvine, published an article detailing the threats to the ozone layer from chlorofluorocarbon (CFC) gases. At the time, CFCs were commonly used in spray bottles and as coolants in many refrigerators, and they were rapidly accumulating in the atmosphere. In the 1980s, ozone in the atmosphere dropped like a rock at the initial onset of the affliction. The Montreal Protocol, 1987 implementation widely considered a triumph of international cooperation—quickly phased out industrial CFCs, and the ozone layer stabilized, though it was still at a depleted level.
Susan Solomon, a professor of atmospheric chemistry and climate science at MIT and his research team, found multiple lines of evidence for the healing. Solomon's team found that, in recent years, the hole is not eclipsing the 12-million-square-kilometer threshold until later in the southern spring, which indicates that the September hole is shrinking. In fact, the researchers believe the ozone hole has shrunk by more than 4 million square kilometers. Furthermore, the hole is not as deep as it used to be. "It gives us hope that we shouldn't be afraid to tackle large environmental problems.".

INTRODUCTION

Ozone is formed from dioxygen by the action of UV light and atmospheric electrical discharges and is present in low concentrations throughout the stratosphere. Ozone is a naturally occurring gas found throughout the atmosphere, with a maximum mixing ratio at altitudes ranging from 15 to 30 km above the earth. This region is known as ozone layer. [1] The **ozone layer** or **ozone shield** is a region present in stratosphere that absorbs most of the ultraviolet (UV) radiation of the sun. The ozone (O_3) concentration is high in this part than in other parts of the atmosphere. The ozone layer is mainly found in the lower portion of the stratosphere, from approximately 20 to 30 kilometres above Earth. The thickness of ozone varies seasonally and geographically. [2] The thickness of ozone layer is measured in "Dobson Units" (DU), where 1 DU = 0.01 nm of the compressed gas at 0˚C and 760mm Hg pressure. [3] The ozone layer absorbs 97 to 99 percent of the Sun's medium-frequency ultraviolet light, which otherwise would potentially damage exposed life forms near the surface. [2] The groundbreaking research for which they were awarded Noble Prize for chemistry in 1995, concluded that the atmosphere only had "finite capacity for absorbing chlorine" atoms in the stratosphere. After being widely attacked by the chemical industry, Molina and Rowland's work was indicated 11 years later in 1985, when a team of English scientists realized the dire implications of their findings: the CFCs in the atmosphere had created ozone hole. The loss of the protective ozone can lead to increased rates of skin cancer in humans and animals. [4]

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Depletion of Ozone Layer

Ozone occurs at two levels, the stratospheric ozone and the tropospheric ozone. The tropospheric (ground) ozone varies with the daylight variations. Ozone near ground is a pollutant and its production is enhanced due to air pollutants, like, nitrogen oxides (NOx) and volatile organic compounds (VOCs). The increase in terrestrial ozone particulates results in their enhanced scattering and improved absorption of UV-B radiations, contributing to global warming by acting as a greenhouse gas and also shows harmful effects on both animals and plants. An increase in the UV-B radiation is one of the major causes for enhanced production of carbon monoxide from dead organic matter and release of nitrogen oxides. The ground ozone along with carbon monoxide is responsible for acid rain causing damage to lung tissue and its long-term exposure can cause permanent tissue damage. Tree leaf and needle losses are linked to acidification and high percentage of ground ozone. Ground ozone concentration is lower in Polar and equatorial regions. The sub-tropical ground ozone concentration in Northern hemisphere is twice the corresponding region in Southern hemisphere. [5] Although, O_3 is present in low concentration (~0.6 ppm) in the atmosphere, it plays an important role by efficiently screening out harmful radiations. The UV rays are of shorter wavelengths ranging from 100 - 280 nm (UV-C), 280 - 315 nm (UV-B) to 315 - 400 nm (UV-A). Of the UV rays, UV-C is completely absorbed by the ozone layer and only 5% of UV-B reaches the earth surface, while nearly 95% of UV-A is able to penetrate the atmospheric layers [6]. When human skin is exposed to UV-A radiation, cyclobutane pyrimidine dimers are produced in significant amount, leading to photo-carcinogenesis of the skin [7].The ability of UV-B to penetrate water bodies affects the cellular DNA in phytoplankton and zooplankton that led to increased mortality due to physiological anomalies. [6] The sunspot cycle leads to an increase in UV-B influxes during its various stages, which causes stratospheric temperature fluctuations. The solar maxima of the sun-spot cycle are responsible for increased UV-C radiation which stimulates the formation of stratospheric ozone. [8] The ozone depletion over the Antarctic has been noticed since 1970s and the Arctic region has also been witnessing the occurrence of an ozone-hole during the last decade. The overall depletion has been increasing at the rate of 0.5% per year since 2000, because of the extensive use of ozone depleting substances (ODSs) such as propellants (in the manufacture of soft and hard foams), refrigeration, air conditioning and as cleaning solvents [9]. The atmospheric release of ODSs such as halocarbons including chlorofluorocarbons (CFCs), hydro chlorofluorocarbons (HCFCs), hydro-fluorocarbons (HFCs) and bromofluorocarbons (BFCs) has led to a significant decrease of the ozone layer. Halocarbons are artificially synthesized gases consisting of carbon and one or more halogens (fluorine, chlorine, iodine and bromine) released in enormous amounts and they are responsible for an increased concentration of Cl and Br in the atmosphere [10]. CFCs (Freons) are a group of colorless, non combustible liquids which are highly volatile substances and poorly soluble in water. Hence, they are mainly released into the air through evaporation during their production and use. These do not bind to soil strongly and thus they can easily leach to the groundwater. The use of these chemicals has been phased out because of their deleterious effects on ozone layer but they may still be found as an environmental hazard as they degrade slowly in groundwater.

CFCs are also found to have health effects which include short-term (acute) and long-term (chronic) effects. Exposure to pressurized CFCs can cause frostbites to the skin and to the upper airway if inhaled. At high temperature, they can degrade to more acutely toxic gases such as chlorine and phosgene. Increased health impacts had been observed with the increase in CFCs concentration [11].

Apart from this, traces of gaseous nitrogen compounds, such as NO, NO_2 and N_2O, present in small quantities in the atmosphere are considered to be the largest ozone depleting substances emitted by human activities exceeding the contribution of chlorofluorocarbons [12]. If these chemicals escape into the environment, they drift up the stratosphere where Cl and Br radicals are liberated by the action of ultraviolet light on their molecule and act as a catalyst affecting the ozone layer at −78°C (critical

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temperature required by chlorine to breakdown ozone at surface of polar stratospheric cloud crystals), where they lead to a complete breakdown of ozone and thus reduce it to oxygen molecules. One chlorine or CFC molecule can destroy 100,000 ozone molecules. As a result the ozone layer becomes incapable of absorbing UV radiations which enter the earth's surface from polar areas, especially from Antarctica and affect various living organisms.

The CFCs have been phased out in both developed and developing countries since 1996 and 2010, respectively. Alternative to CFCs, HCFCs will also be phased out in both developed and developing nations by the year 2020 and 2030, respectively.

The World Meteorological Organization (WMO), 1995 predicted that the depletion of the ozone layer peaked around 1998 and the layer would slowly recover by 2045 [13]. But many researchers do not agree with these predictions [14, 15] and express their concern regarding a delayed recovery of stratospheric ozone [16]. Thus, at present the anthropogenic damage to the ozone layer strongly exceeds its recovery. There is a burgeoning need to reduce the production of industrial products causing ozone depletion and global warming.

The Vienna Convention for protection of Ozone layer was adopted by 43 nations in 1985. It addressed the importance of conservation of Ozone layer and established global mechanism for research, monitoring and exchange of information. Two months later, its adoption by the British scientists announced the presence of Ozone hole over Antarctic triggering concern about human safety. Nearly 60 plus countries met at Montreal in 1987 to come up with a protocol on curbing the Ozone Depleting Sub- stances (ODSs). For the first time the CFCs were identified as a major culprit and CFCs-11, 12, 13, 114 and 115 and Halons-1211, 1301 and 2402 were targeted for reduction. The onus for reduction was more on developed countries, but to encourage developing countries for joining the protocol was made possible through favorable trade benefits. The signatories have been given ten year time for total phase out for enlisted ODSs. It has targeted to 2040 for a total phase out of all kinds of ODSs [17]. The Kyoto Protocol sought reduction of CO_2 emissions and was signed in 1997. [18].

Consequences of Ozone Layer Depletion

The ozone layer plays an important role in the biology and climatology of the earth's environment. Radiations below the wavelength of 3000 Å are biologically harmful and ozone helps to filter-out these radiations. The stratospheric ozone layer protects life on earth by absorbing the damaging, high-energy UV-C radiation. Depletion of stratospheric ozone increases the concentration of terrestrial ozone, which is considered harmful for health. Ozone depletion resulted in global warming by increase of the atmospheric temperature by 5.5°C [19].

Exposure to UV rays due to ozone depletion causes innumerable biological hazards such as variation in the physiological and developmental processes, reduced growth and productivity of plants. Indirect damage caused by the UV-B includes changes in the plant form and distribution of nutrients within the plant. These changes have important implications for plant competitive balance, herbivory, plant diseases, and biogeochemical cycles. Exposure to solar UV- B radiation has been shown to affect both orientation mechanisms and mortality in phytoplankton, resulting in reduced survival rates for these organisms. Solar UV-B radiation has also been found to cause damage to the early developmental stages of fish, shrimp, crab, amphibians and other animals. Most severe effects decrease reproductive capacity and impaired larval development. Increase in solar UV radiations affect terrestrial and aquatic biogeochemical cycles, thus altering both sources and sinks of greenhouse and chemically important trace gases such as carbon dioxide (CO2), carbon monoxide (CO), carbonyl sulphide (COS) and possibly other gases, including ozone. [20] Exposure of UV radiations leads to the formation of patches on skin and weakens human immune system. The UV radiations damage skin either by damaging melanocyte cells or by causing sun-burns due to faster flow of blood in capillaries of exposed areas. Malignant melanoma, a type of skin cancer is also caused by UV exposure which is less common but far more dangerous. Its relationship with UV exposures has not been understood yet but it is thought both UV-A and UV-B are involved [21].

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Studies showed 10% increase in UV-B resulted in 19% increase in melanomas in men and 16% in women. Excess of UV light exposure causes DNA breakage, inhibition and alteration of DNA replication and premature ageing in humans [22].

According to biological classification ultraviolet radiation is divided into three classes-

a) UV-A, 315 to 400 nm (the near ultraviolet ranging into visible). It forms about 7% of solar flux and is particularly harmful to living species.
b) UB-B, 280 to 315 nm (1.5% of the total solar flux). It can be harmful to both plant and animal species, especially after prolonged exposure.
c) UV-C,< 280 nm (0.5% of the total flux) which rapidly damages the biota of all types.[23]

Mending of Ozone Layer

Scientists find evidence that the hole is finally shrinking, because of the phasing out of harmful chemicals 30 years ago. After three decades of observation, scientists have finally found the first fingerprints of healing in the notorious Southern Hemisphere ozone hole. Susan Solomon, a professor of atmospheric chemistry and climate science at MIT and his research team, found multiple lines of evidence for the healing. Over Antarctica ozone hole forms every year, beginning in August and generally peaking in October. Solomon's team compared September ozone measurements, collected from balloon data and satellites, with statistical simulations that predict ozone. [4]

The team found that the September ozone hole has shrunk by more than 4 million square kilometers — about half the area of the contiguous United States — since 2000, when ozone depletion was at its peak. The team also showed for the first time that this recovery has slowed somewhat at times, due to the effects of volcanic eruptions from year to year. Overall, the ozone hole appears to be on a healing path.

The authors used “fingerprints” of the ozone changes with season and altitude to attribute the ozone’s recovery to the continuing decline of atmospheric chlorine originating from chlorofluorocarbons (CFCs). These chemical compounds were emitted by dry cleaning processes, old refrigerators, and aerosols such as hairspray. In 1987, virtually every country in the world signed on to the Montreal Protocol in a concerted effort to ban the use of CFCs and repair the ozone hole. [24]

“We can now be confident that the things we’ve done have put the planet on a path to heal,” says lead author Susan Solomon, the Ellen Swallow Richards Professor of Atmospheric Chemistry and Climate Science at MIT. “Which is pretty good for us, isn’t it? Aren’t we amazing humans, that we did something that created a situation that we decided collectively, as a world, ‘Let’s get rid of these molecules’? We got rid of them, and now we’re seeing the planet respond.”[4]

Tackling the Problem

In the 1980s, ozone in the atmosphere dropped like a rock at the initial onset of the affliction. The Montreal Protocol 1987, implementation widely considered a triumph of international cooperation—quickly phased out industrial CFCs, and thus the ozone layer stabilized, though still it was at a depleted level. The ozone hole size varies from year to year, influenced by changes in meteorology and volcanism, which can make it difficult to identify a healing trend. Scientists believe that it has remained relatively stable since the turn of the century, but the October 2015 hole was the largest on record. Scientists have long thought the ozone layer was recovering slowly, but Solomon and her team—comprising researchers from MIT, the National Center for Atmospheric Research, and the University of Leeds—are the first to rigorously uncover evidence of the healing.

Though the size of the 2015 hole was unusual, Solomon attributes it largely to the April 2015 eruption of the volcano Calbuco in Chile. Though volcanoes do not spew chlorine molecules into the atmosphere, their contribution of small particles increases the number of polar stratospheric clouds that react with human-made chlorine. [4]

Future Implications

These findings suggest that ozone healing is right on pace with the expected timeline. As Blake explained, this shows that the gases that affect ozone are decreasing in the atmosphere.

Both Solomon and Blake expect to see a continued trend of slow healing; a whole recovery is not

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expected until mid-century. The production of CFCs ceased in the 1990s, but has lifetimes of 50 to 100years, so the chlorine molecules produced in the 1970s and '80s are still hanging around the atmosphere. Still, the findings are a happy culmination of decades of work by scientists, engineers, and diplomats around the world. "It's been quite a remarkable history," says Solomon. "It gives us hope that we shouldn't be afraid to tackle large environmental problems."[4]

Conclusion

A large number of environmental problems such as ozone depletion and global warming are associated with increased development and economic growth throughout the world during the last century. It became important to heal them. Several researches were there to sort out the problem of ozone depletion. For this purpose, different conventions and protocols have been adopted to control ozone depletion and its impacts on all life forms. These include Vienna Convention in 1985 followed by the Montreal Protocol in 1987 and the Kyoto Protocol in 1997. These protocols banned the use of ozone depleting substances (ODSs) in both developed and developing countries. Chlorofluorocarbons (CFCs) have been found to be the main cause of ozone depletion and have many health impacts.

Finally, after a long time nearly 30 years, it is made possible to heal the ozone. Susan Solomon and her team noticed this change in ozone layer. Solomon's team found that, in recent years, the hole is not eclipsing the 12-million-square-kilometer threshold until later in the southern spring, which indicates that the September hole is shrinking. In fact, the researchers believe the ozone hole has shrunk by more than 4 million square kilometers. Furthermore, the hole is not as deep as it used to be.

It is a great research. It shows "Nature also has a changing Nature." The signs of ozone mending can lead us to a positive result of saving ozone and environment.

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Lithology, Structures and Field Relations of Bundelkhand Massif Around Chhatarpur, Madhya Pradesh, India

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ABSTRACT

The Bundelkhand craton is a semicircular massif and considered as one of the oldest nuclei in the northern portion of Indian Shield. Geologically, the area consists of older metamorphics as xenoliths within granitoids. These granitoids show colour and textural variations and essentially made up of feldspars, quartz and mafic minerals. Later on these granitic rocks are invaded by younger intrusives include aplite veins, pegmatite veins, quartz reefs, quartz veins and basic dykes. Structurally, the rocks in the study area have undergone several phases of deformation. These deformational forces have given rise several fractures, joints and faults trending in E-W, NE-SW to NNE-SSW and NW-SE directions. The fractures trending in NE-SW to NNE-SSW and NW-SE directions later on filled up by quartz reefs and basic dykes respectively. The granitic rocks also show foliation and lineation. The major direction of foliation is NE-SW. Lineament analysis reveals that the major orientation of quartz reefs is NE–SW direction and basic dykes are NW-SE direction in the study area.

INTRODUCTION

The Bundelkhand craton is considered as one of the oldest nuclei in the northern portion of Central Indian Shield and it occupies an area of 45,000 km², of which the southern 26,000 km² is rocky and the northeastern part is under shallow alluvium. The Bundelkhand craton is bounded by the Vindhyan Supergroup of rocks in the northwest, west, south and the east. It is bounded by the metasedimentaries of Bijawar Group, Deccan Basalts and E-W trending Son-Narmada megafault in the south, WNW-ESE trending Yamuna fault in the north and NE-SW trending Great Boundary Fault in the west (Singh *et al.,* 2007).

Like other Archaean cratons of Indian Shield, the Bundelkhand craton is also composed of typical Archaean trilogy: (i) highly deformed, medium grade gneisses of tonalite, trondhjemite and granodiorite (TTG) composition (3.3 Ga–2.7 Ga), (ii) relatively low grade volcano-sedimentary greenstone belts and (iii) undeformed calc-alkaline granitoids (2.5 Ga) and associated giant quartz reefs. Numerous mafic dykes (2.1 Ga to 1.1 Ga) and associated intrusives have invaded the older rocks of the Bundelkhand craton (Mondal, 2010).

LITHOLOGY OF THE AREA

The study area is a part of the Bundelkhand craton which is the northern part of Chhatarpur district of Madhya Pradesh, India (Fig. 1). The present work has been carried out in and around Chhatarpur township, an administrative headquarter of Chhatarpur district, and covers an area of about ≈712 km² and falls under Survey of India toposheet no. 54P/09. Geologically, the present area includes older metamorphics, granitoids and intrusives. The older metamorphics are mostly found as scattered outcrops and enclaves into the granitic rocks (Fig. 3b). The older rocks are found as enclaves and xenoliths within the younger rocks of granitic composition which are later injected by the quartz reefs and basic dykes along the fractures, joints and shear planes during a period of deformation.

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Bundelkhand area is noted for its giant quartz reefs, which run characteristically straight in NE-SW direction for a long distance in the form of persistent long ridges (Fig. 3e). The study area is traversed by numerous quartz reefs trending in NE-SW and NNE-SSW directions. The relation of these reefs with the adjoining rocks is difficult to find out because their flanks are covered by debris of quartzose material.

The geological and lineament maps of the present area have been prepared using IRS ID LISS III FCC image, District Resource Map published by the Geological Survey of India and data availed from bhuvan-nrsc web portal (Fig. 2 and Fig. 4). The obtained data is verified by selected filed checks. An attempt has been made to classify the granitoids and enclosed xenoliths, their relationship with associated rock units and to study the field relations of these rocks.

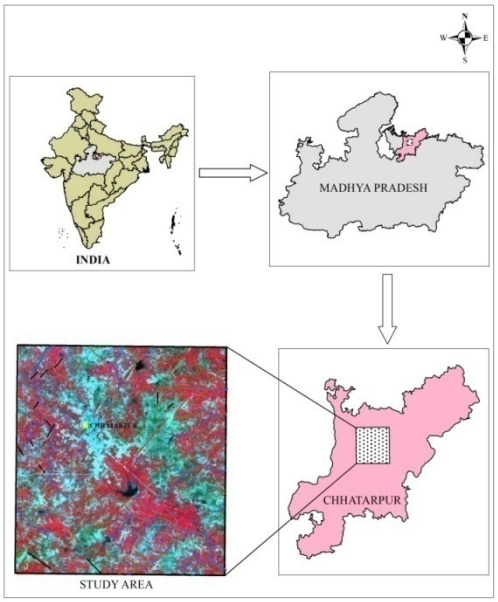

Fig. 1. Location map of the study area.

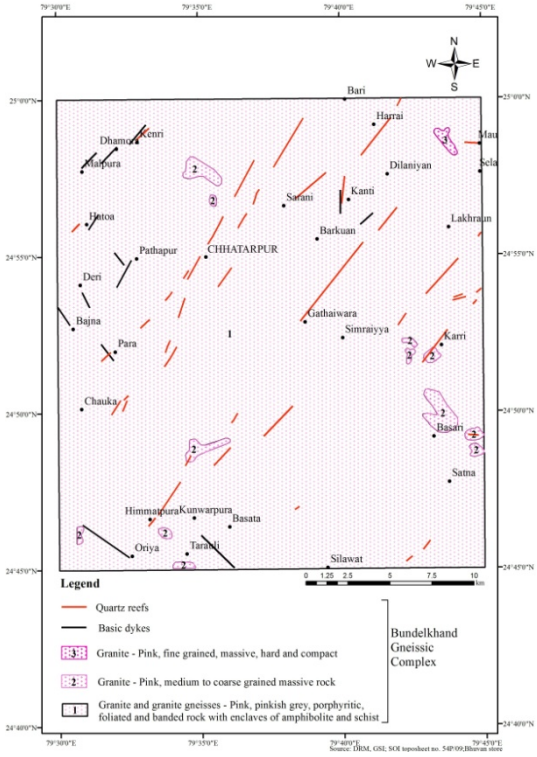

Fig. 2. Geological map of the study area.

The following lithological sequence has been established in the study area after the field observations.

Soil and alluvium		Recent
Intrusives	Dolerite dykes Quartz veins Quartz reefs Pegmatite Aplite veins	

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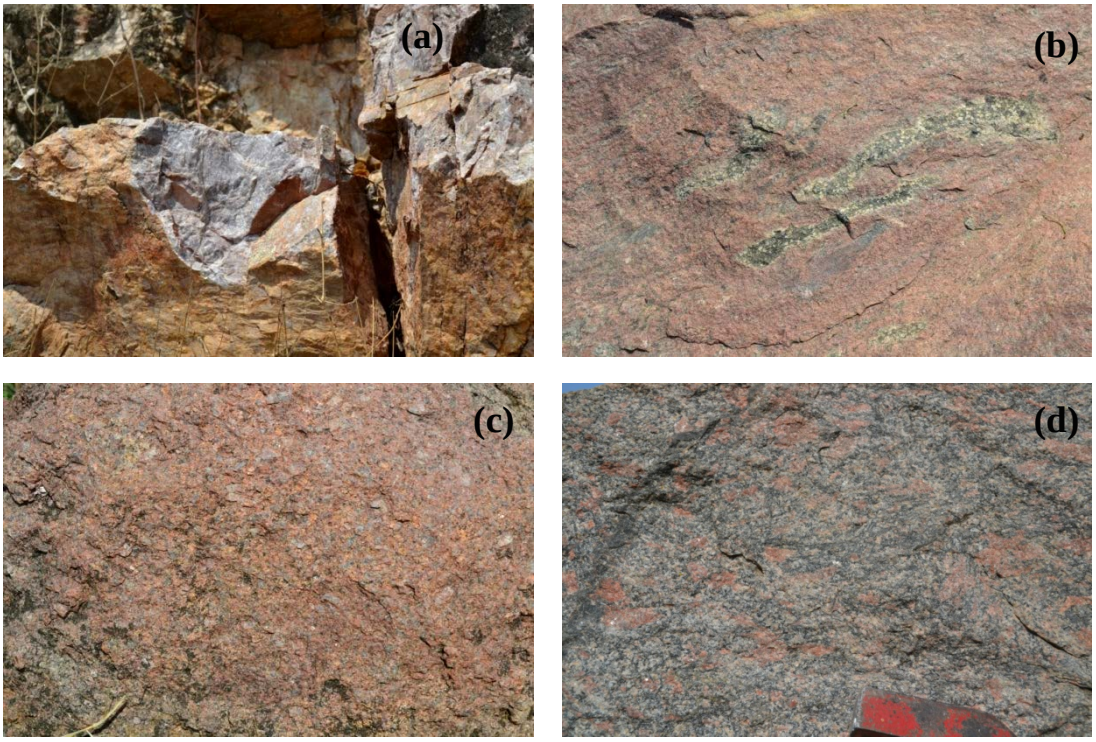
Granitoids	Fine grained pink granite Medium grained leucogranite Coarse grained leucogranite Medium grained pink granite Porphyritic medium grained granite Coarse grained pink granite Coarse grained mafic rich granite Porphyritic coarse grained granite Coarse grained grey granite	Archean to Paleoproterozoic age
Older metamorphics	Amphibolite Hornblende-biotite schist, biotite schist Quartzo-feldspathic schist Quartzites	



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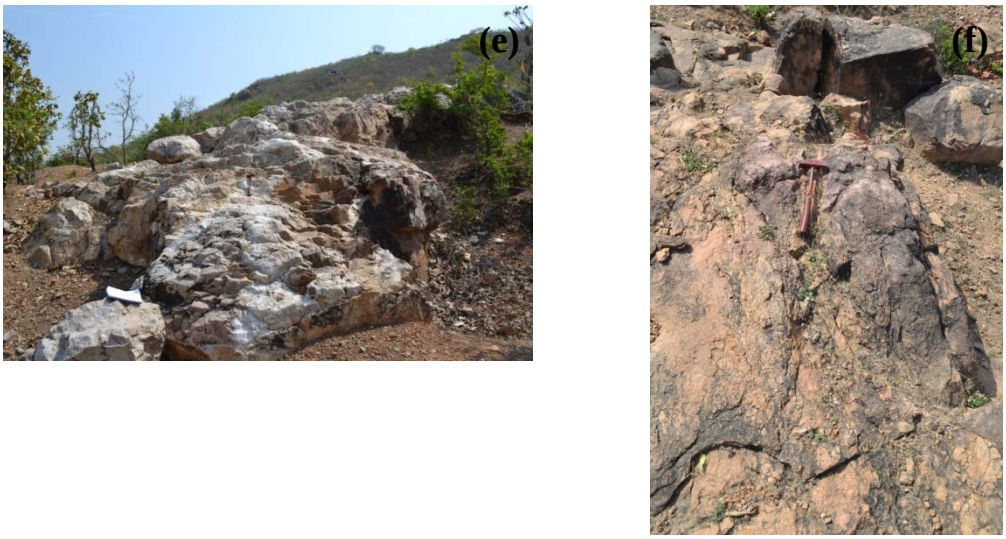

Fig. 3. Field photographs of rock types in the study area.
(a) An outcrop of quartzite showing open vertical joint.
(b) Hornblende-biotite schist as enclaves within the medium grained pink granite.
(c) Coarse grained pink granite. **(d)** Porphyritic mafic rich granite. **(e)** Elongated vertical quartz reef. **(f)** Intrusion of a pegmatite vein within coarse grained granite.

STRUCTURAL STUDY

The structural features of the study area comprise of strike and dip of joints, foliation, lineation, faults, joints and shear zones. Outcrops of the older metamorphics are very few in the area and their study is limited. They occur in the form of isolated patches in the granitic rocks. Various structural units like strike, dip, foliation, lineation, folding, faulting etc., were carefully noted in the field.

Strike and Dip

Schists occur as elongated bodies in the granitic rocks. The strike direction of schists ranges from N50°E-S50°W – N80°E-S80°W. The constant dip amount with slight variations, however, indicates that older rocks were not disturbed much during the process of migmatisation. The normal strike of granitic rocks is E-W direction.

Foliation and Lineation

Foliation in the older metamorphics is marked by platy mica flakes. A prominent primary foliation is observed which runs in N60°E–S60°W to N70°E–S70°W direction. This is the regional foliation direction in the study area. Crude foliation is marked in the granitic rocks of the area by the orientation of mafic minerals, segregates of mafic minerals, segregates of inclusions and the elongated grains of feldspars and quartz. All the mafic minerals and enclaves are arranged and oriented parallel to each other in the granitic rocks. Generally, feldspar phenocrysts are well-oriented. The strike of crude foliation ranges from N55°E–S55°W to N75°E–S75°W. Pink and grey granites, only at few places, show the development of crude foliation which is revealed by the planar parallelism of the longer axis of feldspar phenocrysts and the mafic minerals.

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Lineation is observed in hornblende-biotite schists, biotite schists and amphibolites. In hornblende-biotite schist small prismatic crystals of hornblende are arranged in a parallel manner with their longer axes oriented in the foliation direction (Fig. 3b). No lineation and foliation is observed in quartzites (Fig. 3a).

Minor Faults and Slips

Several minor faults have been observed showing small off-settings from one centimetre to two centimetres. Such minor faults are very common and are locally developed around the contact zones of country rocks either with granites or with quartz reefs (Fig. 7b). Most of the slips have affected the quartz and aplite veins, indicating that the dislocation took place at a later stage.

Joints and Fractures

Joints are well developed in the study area. They are more frequently developed in medium to coarse grained granites. Vertical and horizontal joints are observed in the field. Vertical joints − the strike direction of these joints is NE-SW. These joints are regional joints and filled up by quartz veins. In few cases these are developed in E-W direction. The joints may be formed when the granite mass was towards the last stage of consolidation. Horizontal joints − these are the joints which run parallel to the horizontal plane (Fig. 7a). They are developed only in granitic rocks. The strike direction of these joints is NW−SE and NNE−SSW. They are primary structures which are developed during the cooling of granitic mass due to gravitational pull. In grey granites, the strike direction is N35°W-S35°E. Joints of pink and grey granites show divergence in nature.

According to the field study, these joints show three distinct directions trending in NE−SW, NW−SE and NNE−SSW. NE−SW and NNE−SSW trending joints coincide with the most frequent trend of quartz reefs of the area. Aplite, pegmatite and quartz veins have been emplaced along the tensional joints (NE-SW), and basic dykes have been intruded along the shear joints (NW-SE).

Shear Zone

At a distance of 1 km east of Hama village, a sheared zone trending in E−W direction has been noticed in the pink granites at the southern flank of the quartz reef.

LINEAMENT ANALYSIS

In the study area, 137 lineaments are delineated. Three prominent trends of these lineaments have been observed and analysed, which reveals that they trend in NE-SW, NNE-SSW, NW-SE and E-W directions (Fig. 4). The frequency and the length of these lineaments have been plotted on rosette.

The analysis of lineament frequency in different directions in the area reveals that the first set majorly trends in the NE-SW direction corresponds to the quartz reefs and second set trends in NW-SE which represents the basic dyke intrusions within the massif (Fig. 5,6).

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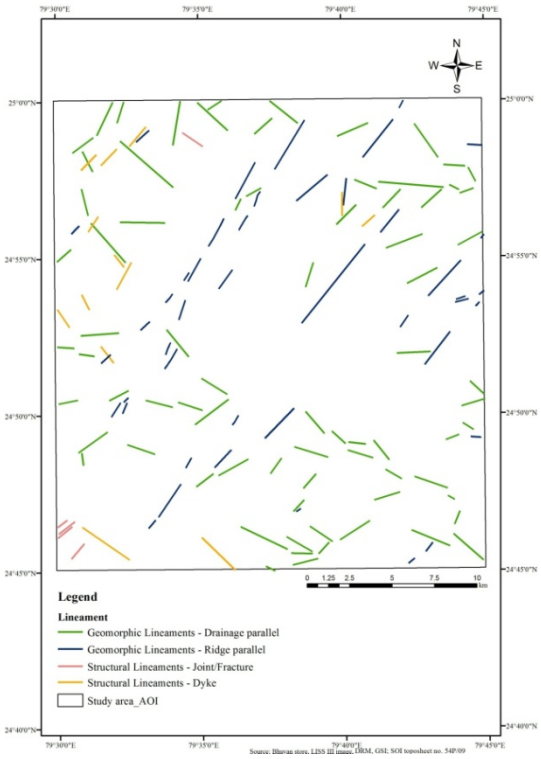

Fig. 4. Lineament map of the study area.

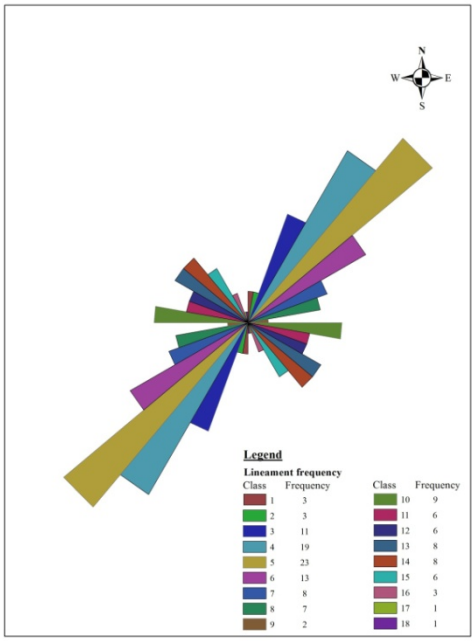

Fig. 5. Rose diagram showing lineament frequency.

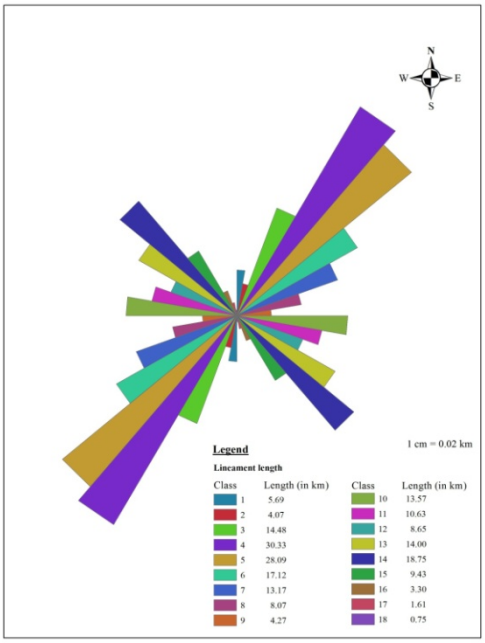

Fig. 6. Rose diagram showing lineament length.

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FIELD RELATIONS

The study area is mostly covered by various granitoids in which pink and grey granites are the most important variety. These granitic rocks exhibit considerable variation both in texture and mineralogical composition (Fig. 7c,7e). Pink granites occupy a greater part of the area than grey granites. The older metamorphics are observed as inclusions in the granitoids. Among these rocks – quartzites (Fig. 3a), quartzo-feldspathic schists, hornblende-biotite schists, biotite schists and amphibolites are the important units. These rocks occur as discontinuous masses, patches and lensoids in various size ranges from few centimetres to two to three metres. Inclusions of hornblende-biotite schists, biotite schists, amphibolites, etc. occur as patches or lensoids of various size and shapes in porphyritic coarse grained and coarse grained mafic rich granites (Fig. 3d) are often observed. Inclusions of hornblende-biotite schists are very common in comparison to other inclusions (Fig. 3b). These inclusions show orientation in NW-SE direction and remain always parallel to the contact plane with the enclosing granite.

Generally, these inclusions show sharp contact with granites. At some distance from the contact in the direction of dip, these inclusions of schist are feldspathised. This stage represents the zone of migmatisation. At some localities exposures of granitic rocks show mixed nature. About 2 km north of Basari village, these rocks are intruded by aplite and pegmatite veins (Fig. 3f,7d). Granites show foliation parallel to the contact in the marginal parts. Development of ferromagnesian minerals into the leucogranites indicates migration of basic constituents in the process of migmatisation. Generally, different varieties of granites and schists occur mixed with each other and thus, it is very difficult to find out an outcrop made up of one rock type.

In most of the cases, within a very short distance the same outcrop may exhibit different texture. The passage from one type to another varies from occasional sharp contacts to mostly gradational. The contacts between the rocks of mafic rich minerals and mafic poor minerals are sharp and clear and differ in their texture and colour (Fig. 7f). It is difficult to find out the sharp contact between the two adjacent varieties has the same mineral composition but differ in their crystallanity and granularity. The coarse grained granitic variety alternating with fine grained granite is seen at 500 m south of Atrar, 800 m SE of Basari and 500 m west of Pahara villages. It is normally observed

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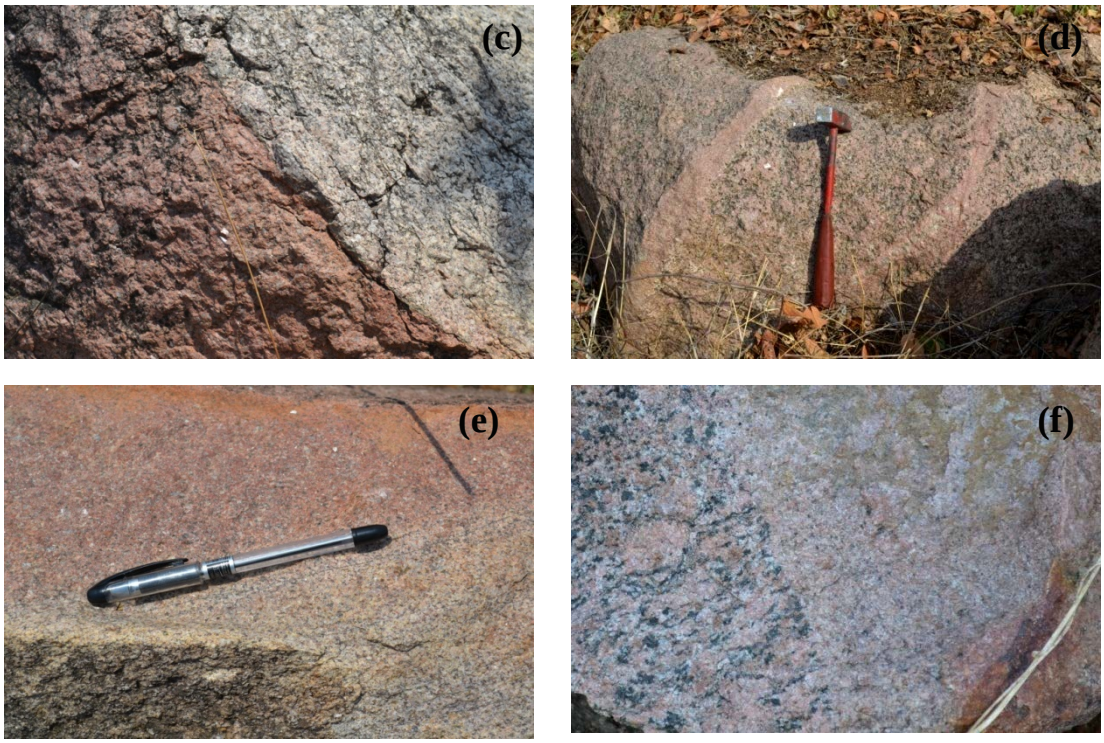

Fig. 7. Some field aspects of the rocks in the study area
(a) Vertical and horizontal joints in medium grained granite. **(b)** Secondary quartz veins intruding quartz reef. **(c)** Contact between two contrast granites. **(d)** Medium grained pink granite intruded by aplite veins. **(e)** Variation of grain size in granite.
(f) A sharp contact between the porphyritic medium grained granite and medium grained leucogranite.

that change in the grain size is usually accompanied by some change in the mineral composition. Sometimes, porphyritic coarse grained granites are traversed by the bands of fine grained granites. It is observed that the fine grained varieties are homogenous, equigranular in nature and usually poor in ferromagnesian minerals. The coarse grained varieties are always comparatively richer in ferromagnesian minerals (Fig. 3d). The alternate arrangement of the coarse grained and the fine grained granites show their mutual relationship, where the overlying rock has been partly removed by erosion, the underlying rock is seen through the eroded parts of the overlying coarse grained granite. Probably, this is the explanation of their mixed occurrence in one and the same outcrop. This type of occurrence has been particularly noticed at 500 m west of Pahara village, where the cover of the porphyritic granite has been partly eroded and country rock is well exposed to the surface.

Another important feature in the study area is the occurrence of one type of granite in another type as inclusions which vary from small patches to large blocks. The inclusions of coarse grained grey granite or coarse grained mafic rich granite rich in fine grained pink granite or vice-versa are very common. The contact of grey granites with coarse grained pink granites (Fig. 3c) is gradational. The contact between grey granite and pink granites are sometimes very sharp and sometimes gradational. Such contacts are observed at 500 m west of Pahara village on major scale. The contact of fine grained pink granite with various granites is very sharp. At 1 km east of Hama village, medium grained granite appear to be brecciated along the southern flank of a quartz reef

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and is trending in E-W direction. Besides these granitic varieties, other litho-units like aplite veins, pegmatite, quartz reefs, quartz veins and basic dykes are also encountered in the area.

Bundelkhand area is noted for its giant quartz reefs, which run characteristically straight in NE-SW direction for a long distance in the form of persistent long ridges. The study area is traversed by numerous quartz reefs trending in NE-SW and NNE-SSW directions. The relation of these reefs with the adjoining rocks is difficult to find out because their flanks are covered by debris of quartzose material.

Pegmatite veins intrude into coarse and medium grained pink granites is noticed at 500 m south of Atrar and 800 m SE of Basari villages, which is usually 0.20 m to 0.45 m in width and up to 15 m in length, and contains biotite only in contact with biotite bearing coarse grained pink granite (Fig. 3f). At some places, pegmatite shows few books of muscovite with quartz and pink feldspar and is devoid of any accessory minerals. Quartz veins of small dimension ranging from 1 to 3 cm in thickness intruded medium grained pink granites are also observed at some places. At a distance of 1.6 km SW of Pathapur village, thin quartz veins consisting oxidised sulphide minerals are intruding coarse grained pink granite. At some places, the granites contain numerous thin quartz veins in NE-SW direction and the rocks at the contacts observed were crushed. At a distance of 1.5 km ESE of Barkuan village, a slight displacement is noticed in these quartz veins (Fig. 7b). A weathered dolerite dyke is encountered at 1.6 km SW of Pathapur village, which is dark grey to blackish grey colour and fine to medium grained rock. The dykes are highly weathered and their outcrops are found in the form of detached boulders of variable size. Their contacts with the country rocks are not clear. The trend of the dolerite dykes in the study area is NW-SE direction which indicates the last phase of deformation. To the west of Kenri, to the east of Hatoa and to the west of Kanti villages, three dykes are running parallel to the quartz reefs. To the southwest of Para village, one dolerite dyke cuts across the quartz reef at its northeast flank, roughly at right angles and intruded the adjoining granitic rocks maintaining its NW-SE alignment. From the mutual relationship, it may be concluded that these dykes are the younger rocks of the area.

CONCLUSIONS

After the field observations, it is concluded that many structural units were formed under similar conditions more or less at the same period. Mutual relations, gradational relation, lineation, foliation, joints, fractures etc., are observed between the granites and associated lithounits of the area and these features support the replacement origin of these rocks. Some of the fractures of different granites were filled up by the same composition of pegmatite veins, which indicate the same period of their formation. Pink and grey granites show different types of structural pattern. The crude foliation points to their different mode of origin. Therefore, it may be inferred that the pink and grey granites which show heterogeneity in structures have originated in a different manner. In the study area, the lineament analysis reveals that the major orientation of quartz reefs is NE–SW direction and basic dykes are NW-SE.

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