

## COMPONENT ANALYSIS OF SOME CHEMICAL PARAMETERS INFLUENCING THE STABILITY OF DDVP IN SEA-SEDIMENTS ALONG THE EAST COAST OF INDIA

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The component analysis of some chemical parameters such as half-life period, pH, salinity, total organic carbon (TOC), clay mineral concentration (Kaolinite, Illite, Montmorillonite) and the elemental concentrations (Al, Fe, Ti) showed that only three components collectively retained 98% of variation of the original data. The first component carries maximum co-variance with salinity and TOC, the second component is due to clay-montmorillonite, and the third component is attributed to TOC and Fe. The first component accounted for 69%, the second 28% and the third for 3% of total variation. The impact of TOC on the stability of pesticide, DDVP is much more pronounced by its negative covariance with the half life period as revealed by the first principal component.

KEY WORDS: Analysis, chemical, DDVP, sea, India.

### INTRODUCTION

Organophosphorus pesticides are being widely used throughout the world not only because of their high pesticidal activity and relatively low toxicity, but also for their low persistence in the aquatic environment.<sup>1</sup> Much work has already been done on the stability of these pesticides in different lake sediments and also in different solutions of varying pH-values.<sup>2-4</sup> Recently, we have determined the fate and persistence of some organophosphorus pesticides in the marine sediment collected along the east coast of India during the cruises 139 and 141 of R.V. Gaveshani.<sup>7</sup> The stability of the organophosphorus pesticides were found<sup>7</sup> to have been highly influenced by the different chemical parameters such as pH, salinity, TOC, clay mineral concentration, and elemental concentration, etc. Utilizing the data<sup>7</sup> collected by Sarkar *et al.* (1985) an attempt has been made in this communication to analyse the principal components, responsible for the variation in the stability of pesticide, DDVP (0,0-dimethyl, 2,2-dichlorovinyl phosphate).

### MATERIALS AND METHODS

The entire body of the data had ten variables in all. Each variable carried 16 observations recorded from an equal number of distinct sediment samples. These variables are A: Chemical parameters (I) Half life; (II) pH; (III) salinity; (IV) TOC. B: Clay mineral concentrations are (I) Kaolinite; (II) Illite; (III) Montmorillonite. C: Elemental concentrations (I) Aluminium; (II) Iron and (III) Titanium. Since these parameters were in different units these were standardized by the transformation<sup>5,6</sup>

$$Z = \frac{X - E(X)}{S.D.}$$

in order to bring them to a uniform measurable scale. Here,  $E(X)$  represent the arithmetic mean of the variable  $X$  and S.D. its standard deviation. By this transformation all the variables were expressed as deviates with mean zero and standard deviation unity. The transformed data matrix was then used to find our correlation co-efficients between the parameters as follows:

$$R = Z Z^{T/N}$$

where  $R$  is the correlation coefficient matrix,  $Z^T$  the transpose matrix,  $Z$  and  $N$  the number of observations. Table I shows the correlation coefficient. Since the objective was to study the stability of the pesticides DDVP in a marine environment, it was important to identify the major factors of variation in the data. The correlation matrix of the order of ten was thus subjected to the principal component analysis. This technique compresses the whole body of the data, a multitude of points which collectively form an ellipsoid of multiple axes in a  $n$ -dimensional space, into principal axes so that the principal components of variation are identified. This is achieved by the orthogonal rotation of the correlation matrix till it is reduced to its diagonal form. The elements on the diagonal contain the eigenvalues of the major axes of variation. These along with the coordinates of axes are later used to compute the covariances, i.e. common variations between the variables and the components of variation. The components only represent the meaningful new variables which account for variation in the data, independently of each other.

Table I Correlation matrix.

	Half life	pH	Salinity	TOC	Kaolinite	Illite	Montmor- rillonite	Aluminium	Iron	Titanium
1. Half life	1.000									
2. pH	-0.996	1.000								
3. Salinity	0.936	-0.934	1.000							
4. TOC	-0.919	0.912	-0.881	1.000						
5. Kaolinite	0.988	-0.997	0.929	-0.892	1.000					
6. Illite	0.991	-0.994	0.931	-0.881	0.992	1.000				
7. Montmor- rillonite	0.973	-0.972	0.899	-0.826	0.970	0.986	1.000			
8. Aluminium	-0.975	0.978	-0.924	0.919	-0.976	-0.958	-0.915	1.000		
9. Iron	-0.994	0.995	-0.921	0.931	-0.990	-0.983	-0.956	0.984	1.000	
10. Titanium	-0.992	0.993	-0.929	0.880	-0.991	-0.998	-0.986	0.960	0.984	1.000

## RESULTS AND DISCUSSION

The principal component approach to the correlation matrix gave rise to only three meaningful components which collectively retained 98 percent of variation of the original data. The first component accounted for 95 percent, the second 2 percent and the third 1 percent, respectively. The component loading matrix in Table II depicts common variation within the ten variables. Since a large portion (95 percent) of variation applies to the first component only, it became necessary to rotate the component loading matrix orthogonally in order to bring it to a form that would be

**Table II** Component loading matrix.

	<i>P1</i>	<i>P2</i>	<i>P3</i>
1. Half life	-0.998	-0.023	-0.027
2. pH	0.999	0.039	0.032
3. Salinity	-0.949	0.059	0.308
4. TOC	0.924	-0.354	0.068
5. Kaolinite	-0.995	-0.072	-0.025
6. Illite	-0.994	-0.115	-0.003
7. Montmorrillonite	-0.970	-0.230	-0.009
8. Aluminium	0.981	-0.072	0.036
9. Iron	0.996	-0.019	0.080
10. Titanium	0.971	0.002	0.014
Variation	9.570 (95%)	0.209 (2%)	0.111 (1%)

**Table III** Varimax rotated component loading matrix.

	<i>P1</i>	<i>P2</i>	<i>P3</i>
1. Half life	0.820	-0.548	0.157
2. pH	-0.812	0.563	-0.157
3. Salinity	0.902	-0.402	-0.149
4. TOC	-0.929	0.198	-0.283
5. Kaolinite	0.794	-0.587	0.142
6. Illite	0.778	-0.619	0.110
7. Montmorrillonite	0.701	-0.704	0.083
8. Aluminium	-0.849	0.459	-0.187
9. Iron	-0.825	0.519	-0.218
10. Titanium	-0.810	0.514	-0.146
Variation	6.801 (69%)	2.792 (28%)	0.296 (3%)

amenable to easy interpretation of variances between the component variables. The varimax rotation method employed for this purpose reorganised the total variation as follows: The first component accounted for 69 percent, the second 28 percent, and the third for 3 percent of total variation; the results are shown in Table III.

The first component carries maximum covariances with salinity and TOC and as such it could be attributed to these variables. The third component could be attributed to TOC and ferric ion for similar reasons. The second component is due to the clay-montmorrillonite. Half life has a direct linearity with the first component salinity, while TOC acts opposite to it. The pH shows an inverse relationship with half life. Similarly, all the clay types exhibit a negative relationship with TOC but a positive relationship with salinity. The elemental concentrations of Al, Fe and Ti are directly related to the first component of TOC. The relationship of TOC with the variables is supported by the third component also, though more weakly. The second component shows that montmorrillonite has a strong positive relationship with half life and salinity but negatively influences pH. This clay also influences the elemental concentration in a negative manner.

Thus it is evident from the component analysis of the variables that TOC along with different elemental concentrations seem to be dominating factors in the destabilization of the pesticide. This might be due to the catalytic effect of the trivalent metallic ions on the rate of decomposition of the enolphosphate. As a result

of faster decomposition of the pesticide, the toxic effect to the marine organisms can be supposed to be reduced to a great extent.

## CONCLUSION

The TOC and salinity, montmorrillonite and ferric ions are the major components which influence the stability of pesticide. The TOC is directly influenced by the elemental concentration, while the latter has inverse relationship with clay. This indicates that an increase in elemental concentration could increase the TOC but reduce the clay types. Since TOC along with salinity accounts for high covariance in the first component, the impact of TOC on the stability of pesticide is more than that of montmorrillonite as supported by the second component, and this prompts us to conclude that though salinity has a tendency to bind the pesticide together, TOC can be supposed to break down DDVP much more, so that it might prove less harmful to marine organisms.

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