Problems Related to Cut-Off Levels

Statistical questions may arise when cut-off levels are applied to the evaluation or mining of an ore deposit. These questions are closely associated with the problem discussed in Chapter 11.3 Comparison of Samples Series with Different Support, in particular the comparison between the grades of samples and the grades of the enclosing mining blocks (cf. Sect. 11.3.1). The economic implications of cut-off levels were discussed in Economic Evaluations in Exploration, Chapter 10.1, and the statistical implications are the subject of this chapter. Figure 34 again acts as the basis for the discussion. This figure summarizes Krige’s (1962) fundamental concepts about the relationship between the grades of samples and those of mining blocks. For each grade interval for the samples there is a population of mining block grades that has an approximately normal distribution (e.g. examples for the 4th and 8th columns at the right side of Fig. 34), whereby the mean of the normal distribution for each interval lies exactly on the regression line between the sample grades and block grades. This line is also the VVC-line (KL). It has been shown in Chapter 11.3.1 that the regression line, or VVC-line, intersects the 45° line at the mean value $\bar{x} = \bar{y}$ for the deposit (Fig. 35), so that the mean of all the sample values is the same as the mean of all the block values. However, this is only true if all the blocks are really mined, without the application of a cut-off grade. If individual blocks are selected for mining and more detailed considerations are taken into account, then the universal concept is no longer valid and the statistical problem is changed. The curve on the diagram that includes all the points, the sample grades plotted against the block grades, approximates an ellipse (Fig. 48, upper). If a cut-off $x_c$ is plotted on the diagram (Fig. 48, upper), then the blocks within the elliptical curve can be divided into four fields:

Field I : Correctly classified as economic; the blocks are mined as ore.

Field II : Incorrect classification, since the blocks are classified as uneconomic (below the cut-off limit $x_c$) and are not mined, although their real grades lie above the cut-off grade.

Field III : Correctly classified as uneconomic; the blocks are not mined.

Field IV : Incorrect classification, since the blocks are classified as economic (above the cut-off $x_c$) and are mined, although they are uneconomic.
There is, without any doubt, a diminishment of the grade as a result of the incorrect classification in fields II and IV, because a certain number of economic blocks will not be mined and a number of uneconomic blocks will be mined. There are numerous technical factors, such as the quality of the grade control during the mining, as well as the selectivity and flexibility of the mining method, that have to be taken into account if the blocks are to be mined as they have been classified (e.g. Carras 1986). It is very rare that mining plans are made only on the basis of the exploration sampling, which is usually only drilling, and a closer-spaced sampling is always required for a more detailed mining plan.