Gemmology Today

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Purple Rain

AI for Clarity Grading

Objective Diamond Clarity Grading

Based on GemGuide

Clarity	% of Value D Colour	% of Value H Colour	Clarity	% of Value D Colour	% of Value H Colour
IF	100%	100%	SI-1	39.55%	63.21%
VVS-1	77.73%	95.28%	SI-2	32.73%	52.83%
VVS-2	64.54%	89.62%	SI-3	27.27%	45.28%
VS-1	56.82%	83.96%	I-1	23.18%	37.74%
VS-2	50.00%	79.24%	I-2	11.82%	20.75%

In terms of value, a one-carat, round brilliant cut diamond with a D colour moving from Internally Flawless to VVS-1 will experience a loss in value of $4,200 USD (wholesale based on GemGuide).

What does this mean in real terms?

According to GIA, an 'Internally Flawless' diamond will show no inclusions and only insignificant blemishes under 10X, while a VVS-1 diamond will contain minute inclusions that are extremely difficult even for a skilled grader to locate under 10X.

As an instructor, I find clarity grading the most challenging to teach because of the subjectivity. The fact that clarity has such an impact on the overall price makes it even more challenging. If you are too critical, you will undervalue the diamond. If you are too liberal, you will add too much value.

The GIA Clarity Grading system has become the model for laboratories throughout the world. It is based on eleven clarity grades (FL, IF, VVS-1, VVS-2, VS-1, VS-2, SI-1, SI-2, I-1, I-2, I-3). It does not include the often-controversial SI-3 clarity grade, described as 'diamonds that contain inclusions, which are visible to the naked eye, similar to I-1 graded diamonds, but are, in the opinion of the grader, less noticeable'.

An issue with this clarity system is its subjective nature. It is subjective in that the clarity grades are defined in terms that are subject to varying human interpretation. This is opposed to objective where definitions are in terms not subject to interpretation. An objective aspect of clarity is a measure in millimeters of the size of inclusions.

When Michael Cowing first approached me with his Objective Diamond Clarity Grading concept, I was intrigued. I am a huge supporter of removing subjectivity. It creates unnecessary 'grey' areas that are often exploited.

Michael's system is a form of Artificial Intelligence, (AI is the capability of computer algorithms to imitate intelligent human behavior. Merriam-Webster's Dictionary)

This AI System is comprised of largely objective metrics that imitate the techniques of expert graders, whose proficiency was obtained from extensive experience and practice. To arrive at a clarity grade, the ODCG System evaluates the combined clarity factors in the way that GIA's experienced graders do. The many GIA graded diamond examples throughout the book demonstrate the accuracy and consistency of this system in emulating GIA's expert graders.

Within a few hours, using ODCG a novice clarity grader can achieve consistent results that are comparable to those of a professional clarity grader with years of experience.

Figure 1: One carat diamond whose clarity is a challenging 'call' due to several reflections of a single dark crystal. What do you think? Contact Michael to learn the GIA's call, which ODCG AI gets right.

WELCOME TO ODCG

Learn to clarity grade, emulating the results obtained by lab graders with years of experience, even with tough calls like the diamond in Figure 1, with its several reflections of the single dark crystal located at 10 o'clock deep in the 'heart of the diamond'.

GRADE-MAKERS

Using Michael's AI system, the clarity grade of most diamonds can correctly be found by judging the single largest inclusion or a small number of similar major inclusions. Such predominant features are referred to as the 'grade-makers'. This is because additional smaller inclusions usually do not materially affect the grade. The four main clarity factors (size, number, contrast, and position), evaluated together for the grade-maker inclusion(s), most often determine a diamond's clarity grade.

Size is the main feature among the four clarity factors. Size determines the visibility of a given inclusion, along with the degree of contrast (relief) between the inclusion and the surrounding diamond. The larger the inclusion and the greater its contrast, the more it stands out and the lower the grade.

Number comes into consideration when the largest 'grade-maker' inclusions are more numerous than one. Three or four similar grade-maker inclusions are likely to lower the clarity one grade more than would a single similar feature. Instances with a number of similar 'grade-maker' size inclusions can most often be accurately treated as an equivalent single inclusion having the same total area.

Lastly, consideration is given to the position of the grade-maker inclusions within the diamond. Viewed face-up, inclusions under or just outside the table in what is called the 'heart of the diamond', are most noticeable and are graded most severely. Inclusions touching or near the girdle are least noticeable and are often graded higher than if inside the table.

In very small diamonds where the inclusion size is a significant percentage of the diamond's dimensions a particular size inclusion may be graded more severely. In large diamonds, eye visible inclusions that would be graded I-2 in a one-carat diamond may receive an I-1 grade. This is because the inclusions occupy and interfere with brilliance over a smaller percentage of the large diamond's crown.

In general, the system is found to make the correct grading call independent of diamond size over roughly the range of round diamond diameters from a third of a carat (4.5mm) to a six-carat (11.8mm) stone. Grading calls for inclusions from VVS-1 to VS-2, which are typically less than a fifth of a mm, are most often made independent of diamond size down to a quarter carat, 4mm round, and often smaller.

CONVERSION OF INCLUSION SIZE/AREA TO A LINEAR PERCEPTUAL SCALE

The key to the ODCG system is the conversion to a linear perceptual scale of the measurements (length and width) of the 'grade-maker' inclusions. The conversion is to a numerical score of the grade and the perceptual position within the grade.

To simplify the process, Michael also produced charts at the back of his book that allow the user to quickly assign the clarity grades. After finding the starting clarity grade from the inclusion area score, consideration is given to adjustments to this initial 'call' due to the other factors of contrast (relief), and position.

Of all clarity factors, inclusion size/area is most important. Inclusion size is measured as the sum total area of the grade-makers. The initial clarity grade from inclusion size is adjusted for contrast and position to complete the grade determination.

Figure 2: This 1.11 ct diamond (6.66–6.63 x 4.11 mm) contains four SI-1 size inclusions that have different dimensions, but the same area and contrast, and thus, similar visibility. Each has an area determined to be approximately .035mm^2

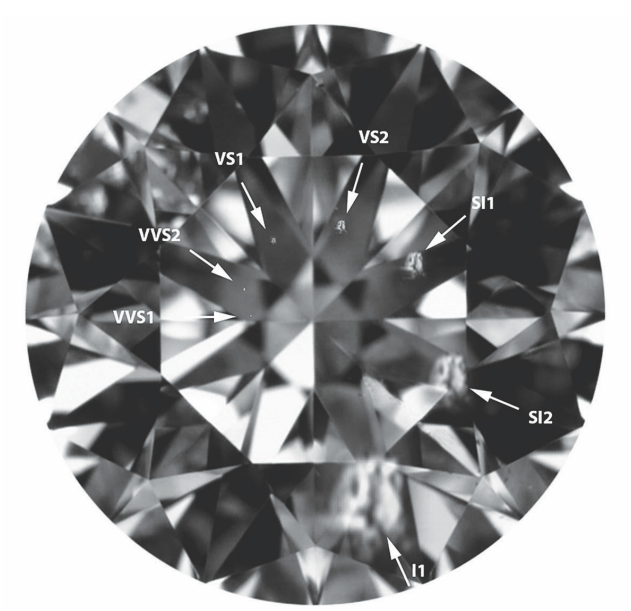


Figure 3: Illustrating the relative increase in inclusion size, doubling from grade to grade, is this spiral of seven inclusions that have been digitally inserted in a 1.11 ct diamond (6.66 x 6.63 x 4.11 mm) shown at 13.3X. The inserted inclusions are sized to clarity grades that range from VVS-1 to I-1.

At the heart of this system is the fundamental discovery of two key aspects of the way professionals perceive and grade inclusion size/visibility.

First, the property of inclusion size/visibility is directly related to inclusion area. If inclusion grade-makers have the same total area, and only differ in their length and width, they have similar visibility, and most often receive the same grade. In Figure 2, there are four SI-1 size inclusions in a 1.11 carat diamond. They have different dimensions but nearly identical area and contrast, and therefore similar visibility. Individually, each inclusion would be graded identically as SI-1, because each has the same area (roughly .035mm^2) and the same contrast (relief).

Second, the increase in inclusion size from one grade to the next is not constant, but essentially follows a doubling of the inclusion's dimensions. That rough dimension doubling, which is a quadrupling in area, is remarkably consistent from grade to grade across the clarity scale. (Perceptual adjustment in grades SI-2 and below for large stones and small melee completes this consistency from VVS-1 all the way to I-3.) Figure 3 provides an example illustrating this doubling of inclusion size with a spiral of clarities from VVS-1 to I-1.

This ratio of 2:1 in inclusion size between grades came about, not by design, but by a natural evolution and later expansion by GIA of the clarity grading terms and their definitions. These were terms used in the diamond trade beginning before GIA's founding. This proportional relationship between grades was named the Clarity 'Golden Ratio' by Gary Roskin, author of 'Photo Masters for Diamond Grading', because of its resemblance to the Golden Ratio in art, nature, and mathematics.

Based upon these two discoveries, the ODCG AI system transforms inclusion size, which is exponentially increasing by 4 times in area per grade, to a linear perceptual scale, where each increase in grade size is plus one throughout the scale. This logarithmic transformation is graphed in Figure 4.

The two perceptually linear graphs serve to convert the grade-maker inclusion's length and width, to the area score and initial clarity grade.

1. Using the blue graph, look up the mm inclusion length and then width measurements to find their corresponding scores.

2. Add those two scores to obtain the total area score.

3. Look up that score using the red graph to find the corresponding clarity grade, and where perceptually within that grade the grade-maker inclusion falls.

Knowing where the inclusion falls perceptually is especially important in the lower grades. The large

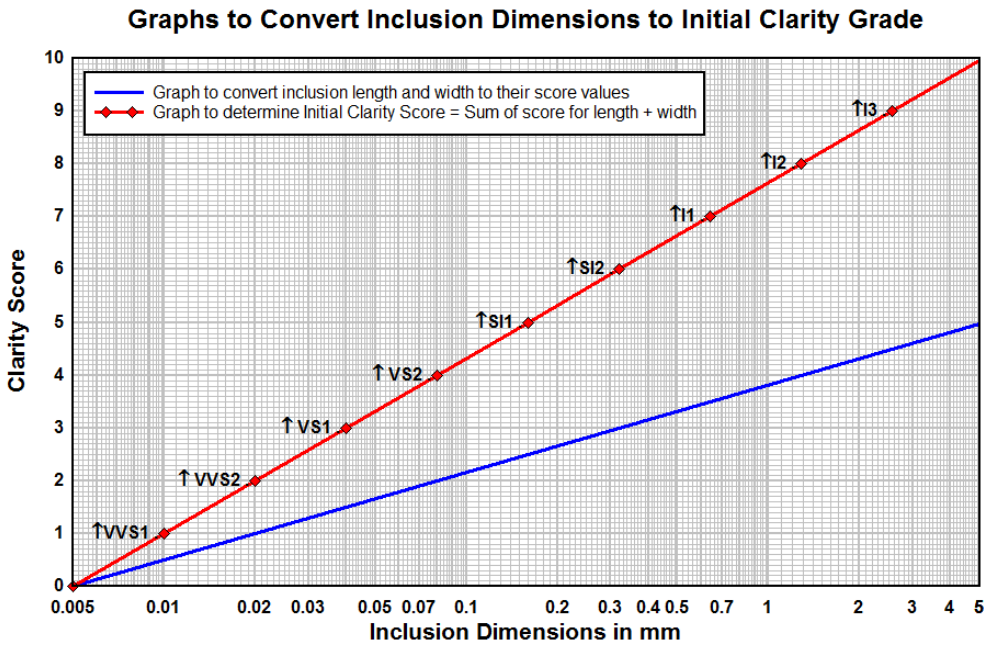


Figure 4: The two graphs serve to convert the grade-maker inclusion's length and width, to the area score and initial clarity grade.

range of inclusion size/area within each grade is 4 times in area from the upper to the lower boundaries. Adjustments to this initial clarity grade for contrast and position will more likely change the grade of inclusions near either the upper or lower boundary.

A unique advantage of this perceptual scale is - there is no need for creating a grade like SI-3. SI-3 is perceptually between middle SI-2 which is 6.5 (SI-2 border at 6 plus a half grade), and mid I-1 (7.5), which is 7. Like the intent of an SI-3 grade, seven is perceptually in the middle between SI-2 and I-1. An inclusion score near 7 is at the border between a low SI2 and a high I1.

CONTRAST

As taught by GIA, inclusion contrast, which is referred to as 'color and relief', 'can affect inclusion visibility as much as size. … Relief is the contrast between the inclusion and the surrounding field of the stone; the greater the relief, the more it will affect the clarity grade.' (GIA, 1994)

To adjust the score for variations in contrast or relief, the system uses a 1 to 5 scale designation of contrast along with corresponding adjustments to the clarity grade.

The adjustment amount (positive or negative) is added to the area score. A one grade lower adjustment is an addition of +1, while a two-grade score improvement is -2.

Five levels of contrast have proven adequate for a large majority of inclusion types and grading circumstances

Very low contrast inclusions lower/improve the initial score by 1 or 2 grades, while very high contrast inclusions can lower the score as much as 1 grade. No adjustment is needed for the most common inclusions that are of 'medium contrast' such as a crystal or white feather.

Adjustments for inclusions near the middle of a grade may not change the initial grade up or down. However, the score of inclusion sizes nearer the borders may cross a boundary, changing the initial grade.

Instances with a number of similar 'grade-maker' size inclusions are found to be accurately treated as an equivalent single inclusion having the same total area. This results in a one grade lower adjustment (+1) when there are about four similar grade-maker size inclusions (four times the area of one of them.) However, lower, closer-to-borderline inclusion sizes are likely to cross into the next lower grade with as little as two grade-maker size inclusions, since two of them increase the score by about a half grade (.5). This underscores the importance of knowing where, within a grade, on this perceptual scale, an inclusion size falls.

REFLECTORS

Features deep enough in the heart of the diamond often reflect in multiple positions. See example in Figure 1. Such inclusions are called reflectors. GIA instructs that 'reflectors lower the clarity grade more than similar, non-reflecting inclusions.' Where there are many reflections

'the effect on the grade is considerable'. Early GIA instruction was to lower an inclusion that had a lot of reflections by one, but no more than one grade. Despite their sometimes-obvious appearance, GIA grading practice treats reflections less severely than would be the case if they were actual inclusions. Reflections are often transitory in nature appearing and disappearing as the diamond is slightly tilted in face-up viewing. When focusing on an inclusion, reflections in the same plane of focus are more noticeable than those out of focus, and thus less noticeable. Consequently the 'in focus' reflections have the greatest effect on the call. Reflections that come into focus below and outside the diamond have no impact on the grading.

POSITION

Adjustments for position are made to the area score that mirror the practice of GIA expert graders. No adjustment is needed for the easiest to locate inclusions within the table or just outside it. Inclusions located just inside or below the girdle will result in a lower/better score, and in some cases, a higher clarity grade. Large inclusions SI-2 and greater are unlikely to be adjusted for position because of their obvious nature anywhere in the diamond from girdle to table.

FINAL GRADING CALL MADE FACE-UP IN OVER-HEAD LIGHTING

It is important to note that just as in GIA grading, the final call is made by observation of the overall inclusion visibility in the face-up position under overhead (not dark-field) illumination.

CLARITY ADJUSTMENT FOR VIEW FROM SIDE OR PAVILION DIRECTION

It is also important to point out that these inclusion measurements and judgments are made from the face up two-dimensional perspective. If a grade-maker inclusion extends more deeply than its face up measurement, such that measuring it from the side or pavilion direction is more than a grade worse, consideration must be given to lowering the face-up grade. In most instances that adjustment is in between the two grade measurements and not more than a grade lower than the face-up call.

EXAMPLE APPLICATION OF OBJECTIVE CLARITY GRADING

In many cases the initial score and grade, based upon inclusion area, becomes the final call. This is the case with typical white crystal or feather inclusions inside or near the table, which require no score adjustment. An example of this case is the single grade-maker crystal in the 1.20ct round brilliant, Figure 5. The inclusion is of

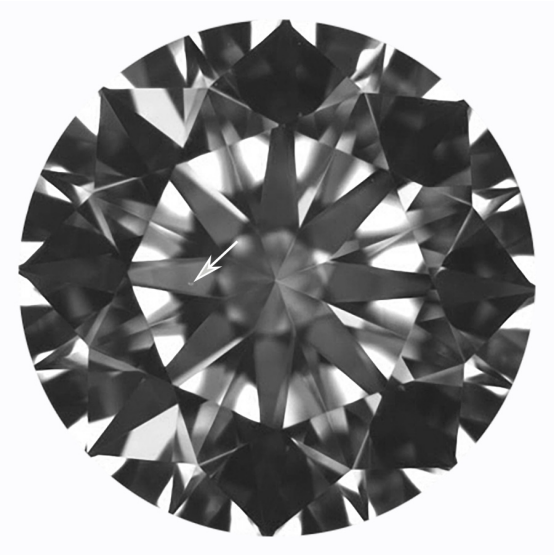


Figure 5: 1.20ct H colour, VS-1 (6.83mm x 6.85mm x 4.17mm) with a .09mm × .042mm crystal inclusion in the table at 9 o'clock

medium contrast located under the table at 9 o'clock.

The grading steps are:

1. Obtain inclusion length and width in mm = .09mm x .042mm.

2. Convert length and width from mm to the corresponding score using the blue curve on the graph or the conversion chart = 2.1 + 1.55.

3. Sum the length and width scores to obtain the initial grade score = 3.65.

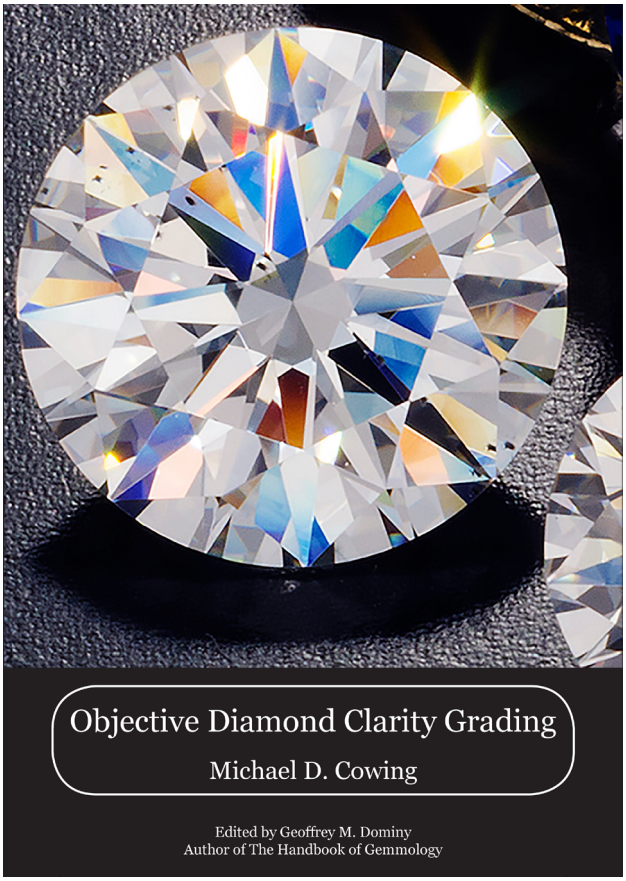
4. Add adjustments for contrast and position, which in this case are 0, since the inclusion has medium contrast, and its position is in the table.

5. This leaves the total adjusted grade = 3.65, which, from the red curve on the graph, gives the diamond a 'solid', middle VS-1.

FROM THE EDITOR

During our recent diamond grading classes in Addis Abeba, Ethiopia, we were amazed at how accurate our students were using Objective Diamond Clarity Grading. Within an hour, the students were confidently assigning clarity grades that matched the GIA grading reports on our diamond study stones. Admittedly, some clarity 'calls' are obvious and do not require using ODCG AI, but there are always problematic diamonds that leave even the most experienced diamond graders scratching their heads. I am firmly convinced that Objective Diamond Clarity Grading will become one of the most significant advances in diamond grading since Richard T. Liddicoat Jr's contributions. Explore ODCG in Michael's book. It will be the best $ 20 USD investment you have ever made.

With over 250 images, **Objective Diamond Clarity Grading** is a complete A to Z on how to clarity grade diamonds with confidence and consistency



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