The crystal in its variety of colours

A number of different colours can be found in the same crystal, such as ametrine (a variety of amethyst). Whilst colour and transparency are the hallmarks of minerals, they rarely help to identify the type of mineral in question.

Malachite, Kakanda mine, Rep. Dem du Congo
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Azurite and malachite.
A mineral can also contain «chromatophorous» chemical elements which absorb light and take on a particular colour. It's the case for the copper ion minerals like malachite/azurite which are green-blue.

Azurite and malachite, Chessy-les-mines, Rhône, France
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Colour does not exist…, or does it?

It would be tempting to identify crystals by colour, but colour is no more than our perception of a secondary physical phenomenon: the absorption of light of a particular energy. Whilst there are reasons for this phenomenon they are very often related to an infinitesimal component of the crystal - more often than not to its defects or impurities.

Colours in crystals can be caused by:

- "chromophorous" or light-absorbing atoms
- chemical impurities
- the size of the crystals
- inclusions
- deformations
- radioactivity

Amethyst (Montana, USA)
Smoky quartz (Curie family , Coll. Minéraux de Jussieu, UPMC)
Ametrine (Photo Eddy-Vierschdrager)
Colouring can be the result of the proximity over millions of years of radioactive rocks. Smoky quartz contains aluminium impurities, but its colour disappears above 300-400°C. The colours vary with the impurities, as in violet amethyst, which is merely an irradiated quartz with iron oxide impurities (Fe^{4+}); when heated up the iron impurities change their oxidation state (Fe^{3+}) and we obtain yellow citrine. Ametrine is a mix of citrine and amethyst.

Cerusite

Pyromorphite

One atom, ... many colours
The colours in these lead-laden crystals change with the chemical state (valence) of the bonds of the lead atoms.
ex : Pyromorphite (Chenelette, Rhône, France), Crocoite (Tasmanie, Australie) & Cerusite (Dundas, Australie)
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Crocoite

Iron oxide and haematite
The size of a crystal can also affect its colour. This is the case with haematite, a form of iron oxide (Fe_2O_3); its larger crystals are a metallic brown-black, but when crushed into very small crystals it can taint water a blood-red colour (its name comes from the Greek «haimatos», meaning blood, and from the Latin «haematites» meaning bloody). This microcrystalline powder was used as a pigment for cave paintings. It is often used with an iron oxyhydroxide called goethite, which is orange-brown in colour and a main constituent of ochre.
Haematite (Elba) and cave painting (Djanet, Algérie) © Coll. Muséum d'Histoire Naturelle de Grenoble, et Institut Neel - CNRS